Bulletin 358 February, 1934

PLANT PEST HANDBOOK FOR CONNECTICUT

II. DISEASES AND INJURIES

G. P. CLINTON

Connecticut
Agricultural Experiment Station
New Haven

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PREFACE

Some thirty years ago, the Station issued a slender bulletin describing plant pests and their control, and gave it the title "A Spray Calendar." It proved very useful and was followed by many revisions, culminating in the present, "A Plant Pest Handbook," issued for convenience in two parts. Part I, Bulletin 344, deals with Insects. Part II, presented herewith, is devoted to Diseases, chiefly those caused by fungi, and to Injuries due to various causes other than insects.

For several reasons, the treatment in this part is somewhat different from that in Part I. Herein are listed all of the troubles on plants cultivated in Connecticut that have come to the writer's notice. To that extent this constitutes a check list. Further, especially as Addenda, there are recorded certain scientific observations from a more detailed and personal point of view. Thus, in the main body of the book, the needs of the practical grower are more nearly served, and the record is completed in the Addenda for those who study plant troubles from a more critical aspect.

The arrangement is similar to that in Part I. The hosts are listed alphabetically and under each a description of the troubles found thereon is given. In case a disease occurs on several hosts, the description is given but once, and then merely mentioned under the other hosts, with reference to the first host. This reference is indicated by "q.v." or by "see host." The hosts and troubles are arranged alphabetically according to common names. For greater accuracy the scientific name, where known, is given also in each case. The usual authorities are not included after these scientific names as is done in most scientific handbooks. One of the reasons for this is that the determinations given are the author's and not those of the scientist who first described the species or later changed it to another genus. Therefore full responsibility is assumed for the names used, in case they are incorrect or involve a matter of judgment, in order not to force this responsibility on some one, possibly now dead, who might have used the same scientific name quite differently, especially in the case of fungi. It has seemed best to be conservative in the use of new names in the place of old ones and of new species, because of the bias that often lies unrecognized back of these changes.

Under each host are taken up, first, the diseases caused by bacteria and fungi, the common name of which is followed in most cases by the scientific one in italics. Following these come the common and scientific names of occasional troubles caused by nematodes. The troubles listed under the general title of Injuries follow under the common names alone. Some of these, as the viruses, may possibly be due to living organisms and so some day should possess a scientific name as well. Most of them, however, are injuries or possibly in some cases diseases (sometimes called physiological) that are due to unfavorable environments of various kinds. The illustrations are merely to indicate the general type of trouble that is caused to a host by a fungus or injury.

To the author's former teachers, the late Professors Burrill, Farlow and Thaxter, due to the high standards they set and the ambition they inspired, he largely owes what knowledge he has gained concerning fungi and plant diseases during the forty years he has been studying them.

In conclusion he wishes to thank the various assistants who have at one time or another been helpful in collecting, determining, cultivating, spraying or observing certain fungi and their injuries. These persons include E. M. Stoddard, Florence A. McCormick, A. A. Dunlap, A. D. McDonnell and Mrs. William W. Kelsey, present assistants, and W. R. Hunt, G. L. Zundel, H. B. Bender and G. E. Graham, former assistants.

G. P. C.

CONTENTS

PLANT PEST HANDBOOK FOR CONNECTICUT

II. DISEASES AND INJURIES

G. P. CLINTON

FUNGI (DISEASES)

Nature of Fungi

Although not so well known to the casual observer and not so numerous as to species as are the insects, fungi are even more important. As parasites they are important because of the injury they cause to a great variety of plants in various ways and in varying degrees. Some true fungi, as well as the bacteria, cause diseases of animals, and some of the worst infectious diseases of man are due to them. The so-called virus diseases of plants, whose cause is undetermined, are placed by some as due to ultra-microscopic bacteria. Further, bacteria and true fungi are useful in many manufacturing processes, especially of foods and beverages. They are also a great help in the disintegration of plant and animal tissues and thereby in maintaining the fertility of the soil for future plant growth, upon which all animal life in the end depends.

In this publication slime molds and bacteria are included under the general term fungi. These are all low forms of plants that lack *chlorophyll*, the green coloring matter of the leaves of flowering and most other plants. Chlorophyll enables the plants that possess it to manufacture out of the water of the soil and the carbon dioxide of the air, in the presence of the sun, the food that they later use for growth. Lacking this ability to form food directly out of inorganic matter, all fungi must obtain it from organic matter, either from other plants or animals. They can do this from either dead or living tissues. When fungi live on dead tissues they are called *saprophytes* and when on living tissues, *parasites*. However, all fungi are not merely Dr. Jekylls or Mr. Hydes; some are both, while others may be one or the other according to the different stages in their life history.

Stages of Development

It is these different stages in the life history of a fungus that often complicate matters. Many true fungi have such distinct stages in their development that they appear to be two different kinds of fungi, until by special culture or infection methods they are found to be merely stages of the same fungus. The stages of some fungi are easily followed by their sequence on the same mycelium, but with others only careful study reveals the various stages in their development. With many, their dual nature has yet to be revealed and perhaps some have lost or have never developed this dual nature. When two distinct stages of a fungus develop, one of them is usually connected with an asexual and the other with a sexual development, as explained later. Often each of these stages has received a distinct specific name under a different genus, before its true nature has been determined.

All true fungi, however, consist of two very distinct stages—a vegetative stage that has to do with search for food, and a reproductive stage that has to do with their perpetuation as individuals, often through unfavorable periods of their existence.

Mycelium. The vegetative stage is usually simple and consists in true fungi of threads, usually branched and more or less divided by cross-partitions or *septa* into individual *cells*, that ramify through the substances from which they obtain their food. These threads are usually single though they may be more or less bunched together as tissues or bodies especially when they form their fruiting stage. The vegetative stage, however, is generally hidden from sight in the medium on which it develops. These vegetative threads are known as a *mycelium* and in a general way correspond to the roots, stems and leaves of a flowering plant. In some cases the mycelium sends special branches known as *haustoria* directly into the host cells to obtain food. It is the enzymes or toxins that the mycelium, directly or indirectly produces that cause the disease, death or disintegration of the plant tissues in which they occur.

Spores. The reproductive parts of the fungus are known as *spores* and these correspond in a general way to the seeds, tubers, runners, etc., of the flowering plants. Many fungi have several kinds of spores, developed at different times. The spores, or at least the *fruiting bodies* on which they develop, are the evident and conspicuous part of the fungi. For instance, the black, sooty mass in corn smut consists entirely of spores while the conspicuous toadstools and shelf fungi are fruiting bodies in which the spores are limited to definite areas.

Spores vary greatly in size, shape and the manner in which they originate from the mycelium. Sometimes they are simply cut off as special cells and at other times they are more elaborately formed in special protective bodies. In general there are two kinds. *Sexual* spores, often called mature or winter spores, are those that result from a more or less direct union of bodies corresponding to male and female units and are similar to seeds in this respect. *Asexual* spores, sometimes known as temporary or summer spores, are produced directly from the mycelium without this fertilizing process. These function somewhat like tubers, runners and cuttings. Each fungus has but one kind of sexual spores, if known, but may have more than one kind of asexual spores. Few spores can be seen individually except as magnified under the microscope, although in a body they may be the conspicuous part of the fungus. However, in certain parasitic fungi, especially leaf spots, it is usually the effect or disease produced on the host rather than the fungus itself that becomes most evident to the naked eye. While the mycelium and its effect on the host are taken into consideration in describing fungi, it is chiefly by the character of the spores and their production that fungi are classified.

Classification

As is the custom in classifying living organisms, fungi are classified here in various groups such as classes, orders, families, genera and species, and sometimes varieties, before we come to the individuals upon which the classification is based. To all of these groups, according to their relationships, scientific names are applied to distinguish them. In this publication, in a semi-scientific, popular way, the fungi are roughly divided into the greater groups as follows: Slime molds or *Myxomycetes*, bacteria or *Schizomycetes*, and true fungi or *Eumycetes*. The last group can be further divided, for our purpose, into Water molds or *Phycomycetes*, Sac fungi or *Ascomycetes*, Imperfect fungi or *Fungi Imperfecti* and Basidial fungi or *Basidiomycetes*. As these groupings and the terminology that goes with them are used in the special diseases discussed later, a brief statement as to each group is desirable here for clarification.

In this paper the scientific name is applied to the stage of a fungus, when distinct, that acts as a parasite, rather than to the mature stage, since the parasitic stage is the one that is really important to the grower. If however, the mature stage is known, even when saprophytic, this is indicated in the general description of the fungus. With rusts all stages are parasitic but when they occur on two different hosts, as explained later, the name is applied to the stage on each host, and the relationship to the other stage is indicated.

Myxomycetes. The slime molds are almost all saprophytes and so are of little interest or importance to the practical grower of plants. They are commonly found on decaying vegetable matter in wet places or after rainy weather. They consist of a naked, jelly-like, vegetative mass of protoplasm that can slowly creep up or on

vegetation and then under dry conditions change rather quickly into dusty spore groups of various types. The clubroot disease of crucifers and certain smothering forms on grasses in lawns are the only forms mentioned here.

Schizomycetes. This group, bacteria, not only causes serious diseases of animals but also of plants. Professor Burrill of Illinois, with whom the writer studied, was one of the very first to prove that plants were subject to bacterial diseases, as shown by his work on pear blight and other troubles. Bacteria are very simple forms of fungi consisting of minute cells that separate from one another by fission (direct division) or else adhere in temporary threads or masses. Under certain circumstances, within their own minute bodies, bacteria produce spores, which are much smaller than the spores of fungi. These bacterial spores are more resistant to unfavorable conditions than the bacteria. The enzymes or toxins produced by bacteria help to destroy the tissues of the hosts in which they develop and secure the food necessary for their existence. In this paper the term "bacterial blight" is used to indicate bacteria on their different hosts. Some thirty species on over fifty distinct hosts are listed. Most of these were originally described by Dr. E. F. Smith of the U. S. Department of Agriculture or his assistants.

Eumycetes, or true fungi. Phycomycetes. These are the lowest form of the true fungi and probably the first to develop. They usually grow best in water or under rather moist conditions. Like all true fungi, they develop from threads or a mycelium, but differ from the higher forms in that these threads are not usually divided by cross-partitions or septa except where spore formation is taking place. The asexual spores are borne singly or in numbers in a covering called a *sporangium*. The sexual spores are produced in various ways by fusion of special fertilizing threads resulting in one or more usually thick-walled permanent spores. These are known as *zygospores* when the fertilizing threads are very similar and as *oöspores* (contained in cell-like coverings called *oögonia*) when the threads are so distinct sexually as to indicate male and female bodies. With this group very often the germination of the spores results in the formation of simple, animal-like cells, *zoospores*, that swim around in water for a time before they infect their hosts or dead matter to form a mycelium. The downy mildews, including the specially destructive potato blight, belong to this group, as do certain of the fungi that occur on insects. Professor Thaxter was one of the prominent investigators of this group.

Ascomycetes. These are called *sac* fungi because their mature or sexual spores, *ascospores*, are borne in hyaline sacks known as *asci*. These in turn are produced in an open layer as in the leaf curls, are included in open cups called *apothecia* (*Discomycetes*), or are enclosed entirely in receptacles called *perithecia* (*Pyrenomycetes*). These latter fruiting bodies may be simple or compound and be free or more or less surrounded by the mycelium from which they are formed. They may be embedded in their host or more or less free on its surface. The fruiting bodies give protection and permanence to the spores borne in them. The spores usually are liberated by special openings in these bodies upon their maturity or at the season favorable for germination and infection of new hosts. Besides the ascospores the Ascomycetes may produce various kinds of temporary or asexual spores. These serve to spread the fungus to other hosts during the growing season. Many of the imperfect fungi, discussed next, will probably be found to belong here as asexual stages when their life histories have been carefully worked out. When an Ascomycete has had its life history determined, we frequently find that the imperfect spore form is a parasite while the sac form is a saprophyte, as in apple scab and many leaf fungi. Besides the leaf curls and cup fungi (usually saprophytes), this group includes among its prominent parasites, scabs of apple, pear and willow, chestnut blight, black knot of plums and cherries, and the powdery mildews.

Fungi Imperfecti. These are the imperfect stages of fungi usually belonging to the Ascomycetes or rarely to the Basidiomycetes. In other words their mycelium in certain stages produces only asexual or imperfect spores but in other stages they have finally been determined, in some cases, as producing sexual spores. The imperfect fungi having similar appearance are grouped together artificially into genera known as *form genera*, such as Fusarium, Fusicladium, etc. Many of these

imperfect fungi have never been sufficiently studied to connect them to a sexual stage and so remain under their form genus. Probably many will never be connected up to a genus having sexual spores. With certain of these form genera, while one species may be connected with a certain sexual or mature genus, others may be connected with a different genus, as is illustrated by certain species of Fusarium. On the other hand species of Fusicladium all seem to be stages of the same mature genus. The connecting of the various stages of a single species of a form genus, therefore, is often an aid to connecting up the other species. Apple scab, for example, is a parasite that injures the living apple leaves and comes under the form genus Fusicladium but studies have shown that it is really merely an imperfect stage in the life history of an Ascomycete known as Venturia that appears as a saprophyte on the old dead leaves. This discovery has lead to the connecting up of other species of Fusicladium with other species of Venturia.

With the imperfect fungi, the manner in which their asexual spores are produced divides them into distinct groups. In the first group, *Moniliales*, the spores are borne externally on the host in more or less evident and modified branches of the mycelium called *conidiophores*. In another group, *Melanconiales*, the spores are formed inside the tissues of the host, usually on little differentiated threads of the mycelium, and ooze forth on the surface as viscid drops or tendrils. A third class, *Sphaeropsidales*, has the spores produced in special covered receptacles of fungous origin called *pycnia* and their so-called *pycniospores* are liberated by a special opening or pore at their top. In a fourth, *Mycelia-Sterilia*, and by far the smallest group, the mycelium fails to produce any spores but often perpetuates itself through special tuber-like bodies of mycelial cells called *sclerotia*, or root-like bodies called *rhizomorphs*.

Basidiomycetes. As far as we are concerned here, the basidial fungi (which are characterized by having certain of their spores borne on pointed threads, *sterigmata*, of special cells called *basidia*) can be classified into three general groups. These are the *Ustilaginales*, the *Uredinales*, and the *Hymenomycetes*.

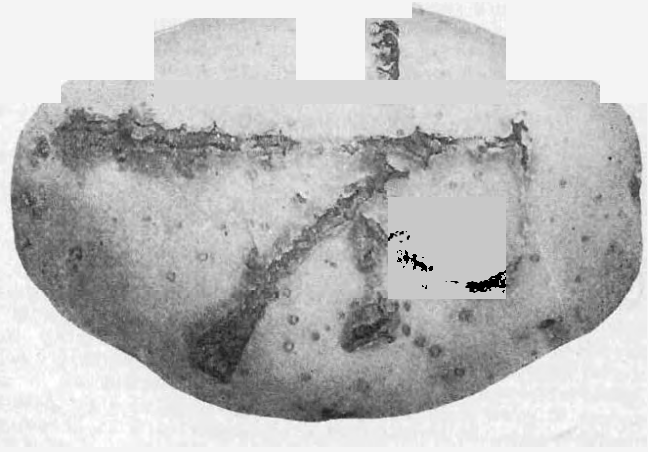
Ustilaginales or true smuts are all real parasites that attack the leaves, stems, fruit and occasionally the roots of a great variety of plants, chiefly the grasses, but rarely if ever occur on trees or shrubs. They are usually distinguished to the naked eye by the black, smutty outbreaks that appear when their spores are matured. A few, however, have embedded and light colored spores that are found chiefly in discolored spots in the leaves. The spores are usually single-celled but there is also quite a variety of arrangements of those that are grouped more or less permanently into compound spore bodies. They cause injury chiefly to the cereals when their spores usually take the place of the maturing seeds. They have only one kind of permanent spores which on germinating usually give rise to a short thread or *promycelium* bearing temporary, basidial spores which cause the infection of the seedlings or plants with which they come in contact. Onion smut and smuts of certain cereals like wheat, oats and barley are the injurious forms most commonly found in this state. Our losses in the cereals, however, are small compared with those in the large grain regions further west.

Uredinales. The rusts are somewhat similar to the smuts and on germination certain of their spores, like those of the smuts, produce basidial spores on a promycelium. They are much more numerous and variable on the hosts they attack and include trees and shrubs as well as herbaceous plants. Also they have a greater variety of spore forms; some species have as many as four spore forms besides the basidial spores. They are even more strictly parasitic than the smuts or any other fungi. While botanists have succeeded in growing the mycelium or certain spore stages of all the other groups of fungi in artificial cultures in test tubes, the rusts have resisted such attempts. Likewise they are the only fungi that may have alternate, or different hosts, for the growth of their distinct spore forms. They are called *heteroecious* (having stages on two different hosts, O-I on one, and II-III on the other) or *autoecious* when all the stages occur on the same host. For instance with the blister rust there are the two stages that appear on the white pine (O-I) and the two others (II-III) that develop only on species of Ribes (currants and gooseberries). On the white clover, however, all four stages appear, one after the other.

The spore stages are as follows: The O or *pycnial* stage appears first. Its function is not known certainly but it is supposed to be a spore stage or to have

something to do with fertilization. The so-called spores, *spermatia*, are small bacterial-like bodies cut off from threads and usually enclosed in a special receptacle called a *pycnium* or *spermagonium*. The I or *aecial* stage (constituting the so-called form-genera of Caeoma, Aecidium, Roestelia and Peridermium) breaks out as open spore masses or *sori* or is enclosed in a special elevated white cup called a *peridium*. The II or *urcdinial* stage produces groups of the *uredospores* that spread the rust to other leaves and plants during the earlier part of the growing season. These spores are often similar to those of the I stage and are of a temporary nature. Later in the season comes the III or *telial* stage whose spores are called *teleutospores*. These are quite distinct, usually thicker walled and often unlike the single-celled spores of the other stages, and may even be composed of two or more cells. They are designed to carry the fungus over unfavorable periods such as winter.

Hymenomycetes. The final class of the Basidiomycetes that we need to consider here are those that include the shelf fungi, toadstools and allied forms. These are the highest forms of the fungi as well as the most conspicuous as to size, form and variety of their fruiting bodies. They result from growth of the inconspicuous mycelia that develop in the living or decayed tissues of the hosts they inhabit or in the humus in the soil. Their spores, usually of simple structure and appearance, are formed on basidia developed on a *hymenium* or fruiting layer of united fungous threads on a definite fruiting body or *sporophore*. Varying according to different genera, this hymenium covers the fruiting bodies with a plain surface, with teeth, clavate structures, pores or gills. Most of the species occur on the ground or on dead wood as saprophytes, though some groups or species are of considerable importance as parasites. The toadstools and shelf fungi that occur on the living bark and sapwood of trees are considered true parasites. Those that cause decay of the heartwood, while not strictly parasites, are at least somewhat harmful even though they develop their fruiting bodies only as saprophytes on the dead trunks later.



Potato showing scab infection as a result of Thaxter's original inoculation. *See* page 250.

INJURIES

Troubles of plants caused by fungi, nematodes and viruses are classified in this publication as *diseases* and those caused by insects and other agents as *injuries*. We think of a disease as a more or less progressive trouble, generally caused by some parasitic organism, and an injury as a more or less local trouble that usually acts quickly rather than continuously, such as is caused by an insect chewing off the tissues of a leaf. These are somewhat arbitrary classifications, however. Some insects can cause diseases, as those that produce galls, and there are many injuries that are caused by agents other than insects. It is with these latter that this section of the bulletin deals. They are sometimes included under such terms as *physiological* troubles or *mechanical* injuries.

Under the two hundred and sixteen hosts listed by common names in the headings given below, there are described, in more or less detail, about one thousand troubles. Of these about seven hundred are caused by fungi, thirty to thirty-five are probably due to viruses and sixteen are produced by nematodes or microscopic worms that cause swellings on the roots or sometimes diseases of the leaves. All of these can be called diseases. The remaining, some two hundred troubles, are classified as injuries, in spite of the fact that in some cases they might be considered by others as diseases, though not caused by fungi, insects or other animal parasites.

Causes of Injuries

The causes of these injuries are of great variety, being agents or factors detrimental to the normal vigor or appearance of the plants or to their various organs or tissues. They may be roughly classified under the following terms: animals (including man), autos, chemicals, cold, drought, dust, electricity, excavations, fertilizers, fillings, fire, frost, fumes, gas, hail, heat, ice, lightning, oils, pruning, salt, smoke, smothering, snow, sprays, sun, water and wind. All of these at one time or another have been called to our attention as causing injuries, but it is not necessary to go into detail at this place concerning them. They are factors, however, that need to be taken into consideration when the cause of a plant trouble is not shown to be a fungous parasite or insect. Special mention of them is made under the various hosts upon which each particular injury has occurred. We can consider here only two of these causes and their resulting injuries,—cold and heat, or the extremes of temperature as they affect the health of plants. These are apparently the most common and most injurious of the troubles listed above.

Injuries Caused by Cold

Cold injures plants chiefly in two ways—by the so-called winter injuries when the plants are in a dormant or semi-dormant condition, and by early or late frosts when the plants are in active growth. Winter injuries vary greatly in the amount of damage that occurs to different species of plants but are especially severe to those grown out of their natural surroundings. Some species are severely injured in very cold winters and are usually those that are normally grown in a warmer climate. Others are less severely or not at all injured by the same degree of cold and are usually those that are natives of that region or of similar regions. Cultivated and fertilized trees, especially if fertilization and cultivation is continued late in the season so that the tissues are not properly matured before cold weather sets in, are more subject to winter injury than are the wild species.

Man is anxious to grow a great variety of plants out of their natural climatic conditions and these naturally suffer most from winter injuries. Trees and shrubs are more subject to injury in this respect than are herbaceous plants since the latter, if tender, are usually properly protected or are limited to greenhouses. Nurserymen, however, have learned largely by experience what woody species can stand winter conditions in various regions, and eventually they limit their stock to those species which escape injury in the normal winters. There are, however, always some species on the border line that are subject to injury, especially in very cold winters.

There are a great variety of ways in which trees and shrubs show these winter injuries, such as blackened sapwood, injured or killed cambium, death of twigs and branches, cankers on the limbs or at the base of the trunk, injured or dead tap or side roots, death or injury to the leaf and flower buds. The presence of water in the soil especially at the base of the trunk and the absence of snow or other mulch for protection have their influence as well as has the severity of the cold. In this state, fruit trees, especially peaches, are apt to suffer if the temperature drops below —10° F. Also the exposure as to hill sides and valleys and the varieties of fruit trees grown are important factors. All winter injuries, however, do not come from unusually cold weather. Mild, warm, winter days that tend to start sap circulation, followed by a sudden drop in temperature, though not severe, may also cause trouble. A not uncommon type of winter injury to evergreens, especially Conifers, occurs when warm, early spring days come before the frost is really out of the ground. Then there results a scorch of the leaves, sometimes called winter-scorch. The leaves lose their moisture before it can be replaced by the roots because of their inactivity in the still cold or frozen soil. As to herbaceous perennials, of course, winter injury is limited to killing or injuring their underground parts so that their growth the following season is abnormal.

On the other hand, frosts, coming late in the spring after leaves and blossoms begin to grow, may kill these or cause injury to certain of their tissues or organs such as epidermis, chlorophyll, petals, anthers or styles. Moisture on the fruit may result in local russeting in frosty weather. Early set vegetables are also often severely injured or killed by such frosts. Likewise early frosts in the fall often cause harm to crops not yet matured or harvested. When one does not know that frosts have occurred or is ignorant of their effects on certain plants, he may be confused as to the cause of the trouble.

Injuries Caused by Heat

Heat, the second serious trouble of plants, shows its effects in a variety of ways —scorches, wilt of leaves, death of plants or their tissues, baking and dropping of fruits, prematuring and abnormal blossoming of vegetables. Sometimes the trouble is the direct result of the heat, but usually it is an indirect one resulting from lack or loss of water. Scorch of leaves is often of this nature when muggy days are suddenly followed by bright hot days or when very dry weather accompanies a long period of hot days.

It has seemed to the writer that if man could control the weather he would do away with most of the troubles of his crops. It is these variations of the weather, combined with insect and fungous pests which are largely regulated by it, that help to make agriculture so interesting and at the same time so uncertain or even hazardous as a method of securing a livelihood.

PREVENTION OF DISEASES AND INJURIES

In the control of *diseases*, since they are caused largely by parasites, the methods must aim to prevent the particular parasite from getting a start on a particular plant and, if it does start, to prevent its spread to other parts of the same plant or to other plants. This is especially true of fungi, which cause three-fourths of the troubles listed here. Once a fungus, through its spores, gets inside the tissues of the host, no treatment will kill the fungus without killing the tissues of the host that surround it, although with certain spray treatments one can often prevent propagation of the external spores and so limit the spread somewhat. Therefore all treatments must be largely preventive.

On the other hand *injuries* usually come on suddenly, rather than continuously, and so are even more difficult to remedy. One must foresee the trouble as likely to occur and so ward it off by some special treatment that ordinarily the plant does not enjoy. On the whole the discussions given here relate chiefly to preventive treatments against diseases rather than against injuries.

Disease-free Seeds and Plants

Sometimes fungous diseases are carried in or on the seeds or plants when they are first planted. They may carry a fungus either by the mycelium that has already

gained entrance into the tissues or by the spores merely mechanically attached to the tissues but ready to gain entrance under favorable conditions. This latter condition is especially true of seeds which upon their germination may favor infection by the attached spores. So the first step in controlling fungous diseases is to use seed and plants that are grown under conditions free from the fungi that are ordinarily troublesome to them. This is especially desirable in varieties that are known to be very susceptible to certain diseases.

In the case of grains, certain smuts gain entrance through spores that have already partially infected or are mechanically adhering to the seeds. It is much more desirable, therefore, to obtain seed from fields where smut is not present or at least not very evident, than from those where it was abundant the previous season. Likewise certain vegetables, such as celery with late blight, are known to carry disease through infected seeds. With perennial plants, it is much safer to avoid trouble by the use of bulbs, corms, tubers, etc. that come from fields or regions where there was no infection. Sometimes this infection can be discovered by a careful examination of the stock to see if rot, sclerotia or some fruiting stage shows. In some cases seeds or bulbs have been treated before distribution to guarantee a greater freedom from certain troubles. In other cases, as with mosaic on potatoes and raspberries, certified tubers or plants are sold from fields where the absence of these troubles above a specified amount has been verified by inspection.

Immune and Susceptible Varieties

On the other hand, some species and varieties, especially horticultural ones, are known to be more resistant, and some more susceptible, to certain fungous diseases than are other varieties and species used for a similar purpose. Unless one needs a particular plant for special reasons it is better to use the more resistant varieties and to avoid those that are known to be especially susceptible. It frequently occurs that the susceptible variety of a food plant is more tender and better in eating quality, or in case of a flowering plant, has more beautiful blossoms. The grower naturally prefers these qualities and therefore runs his chances of trouble as regards disease. There are, however, many susceptible plants in which these desirable qualities are not so prominent, and therefore it is better on the whole to omit them.

Plant breeders are constantly increasing the number of plants resistant to definite diseases in which they retain or build up the factors of resistance. Experience has taught the grower and further experience will add to his knowledge, so that he may know what varieties of greenhouse plants, and to a less extent of those that are grown out of doors, are strongest in their resistance to certain diseases. Orchardists already know that McIntosh is a variety of apple that is especially susceptible to scab, but since it is a very desirable variety, spray treatments have been developed for its protection against this fungus. On the other hand, spraying is much less effective on Wealthy, which is very susceptible to rust. Where rust occurs seriously it is therefore better to omit such a variety.

Special Protections

Another way in which we can help to avoid trouble from plant diseases and injuries is by special care as to when, how and where the plants are grown. The following precautions are indicated as examples.

Mulch. Mulch, either snow, leaf or earth, is often the means of protecting perennial plants, especially trees and shrubs, against winter injury. Snow in severe winters is often protective in this way. It is sometimes found that on hills where the wind has blown the snow away, the injury to orchard trees, especially at the base and roots, is more evident than in another orchard where the snow has remained as a protective layer. Likewise in severe winters, injury on certain shrubs, such as privet, merely extends down to the snow line. Other less hardy shrubs, such as box, and certain evergreens, sometimes have to have special coverings to protect them from severe winter weather. In the orchards, especially peach, the growers often protect the base of the trees by a dirt mulch to prevent an open space between the trunk and the surrounding earth in which water might accumulate and in severe weather cause a girdle type of injury.

Rotation. Another form of protection is by rotation which helps prevent the accumulation in the soil of diseases such as Fusarium, which are harmful to certain crops if grown continuously. Any crop grown continuously on the same soil tends to increase its diseases through the accumulation of spores, etc., from the dead tissues that remain on the land after the crop is harvested. Rotation to a different type or species of plant, therefore, is a way to help avoid unusual troubles of this type.

Clean culture. Special protection by clean culture is another way of lessening **plant diseases.** Clean culture not only keeps down the weeds, thus allowing the crop to get all of the available fertilizer and moisture, but it also helps to get rid of the insects, especially lice, which might carry the germs from the diseased to the healthy plants. It also helps to keep out those weeds that may develop special fungous diseases, which can in turn spread their diseases to the closely related cultivated crop.

For example, clubroot can develop on certain weeds and so be a menace to cultivated crucifers planted there, even if the latter did not bring in the clubroot themselves. Likewise the downy mildew of spinach is the same or so similar to the mildew common on lamb's quarters that there is a chance that the oospores commonly developed on the latter can carry the trouble over the winter and become a source of infection to the spinach when planted on the same land.

We do not know enough concerning the relationships of these weed fungi to those of similar fungi on related cultivated crops to be sure how much effect they have in starting trouble on the latter. Perhaps special strains in time may also help to start new diseases on the cultivated crops because of their relationship.

Finally, clean culture includes gathering up and destroying the infected plant tissues in the fall to lessen the chances of infection the following year from spores, sclerotia or mycelium, especially when the same perennial plants come up or annuals of the same or similar type are to be planted again.

Fertilization

Fertilizers of the chemical type are apparently safer to use, so far as discouraging disease germs for the succeeding crop on the land, than are those of organic origin, such as animal manures, fish-scrap, etc. This is especially true where the manure is not well rotted and came from animals fed on infected refuse from a diseased crop similar to one that is to be planted next on the same land.

Apparently acidity of the fertilizer may also have something to do with certain troubles. For instance, manure from animals that have been fed with scabby potatoes possibly might carry the germs of the scab as well as furnish an alkaline fertilization in the soil. Likewise such manure is very favorable for the development of the scab already there or carried in by the seed tubers. A chemical fertilizer, such as lime or wood ashes, would also be favorable for the development of scab because of the alkaline reaction. Lime, on the other hand, is used as a remedy for clubroot of crucifers because its alkalinity helps to keep down infection from the germs of this slime mold.

An acid soil or an application of an acid fertilizer is likely to invite injury to the roots of certain plants, especially seedlings, by favoring development of the Rhizoctonia fungus. A sod or a green mulch crop plowed under but not thoroughly rotted before the planting of the crop often will favor bacterial injury in certain plants, especially in a wet season.

Some persons seem to think that a well fertilized crop is less likely to develop fungous troubles than one poorly fertilized. My opinion, on the contrary, runs in the opposite direction. Good fertilization tends to develop luxuriant vegetation and this is often of soft growth in contrast to that of the slower, hard growth of the poorly fertilized plants. This soft, quick growth with favorable moisture conditions is more readily attacked, weather conditions being equal, than less luxuriant, poorly fertilized growth. For instance the author has known greater injury from brown rot on peaches stimulated to luxuriant growth by nitrate of soda than on those not so stimulated. This was partly due to the softer and larger growing fruit, but was also due to the denser foliage favoring infection because of more moisture for a longer time on the fruit in damp weather.

In a different way injury rather than disease may result from continuous or late fertilization and the manner of its application, because the fertilizer favors late growth and subsequent winter injury and if applied too near or too strong, may have direct injurious action on the seeds, leaves or roots.

A way of stimulating growth of trees that have been injured by drought, cold, or other causes is the crowbar method of fertilization that is coming more and more into use. This consists of drilling holes, at regular places around the tree, by means of a crowbar that is driven down twelve to eighteen inches, as needed. A large handful (about one-quarter pound) of a complete fertilizer is then placed in each of the holes and is washed into the soil by means of a garden hose. A 4-8-4 or a 5-8-7 fertilizer, as most available, may be used, though some seem to prefer one higher in nitrogen. From two to twenty-five pounds, according to the size of the tree (two to thirty-six inches in diameter), may be used. Some tree men use even larger amounts for very large trees. From eight to sixty holes can be made, in a zigzag way, beginning just beyond the spread of the branches and running in about two-thirds of the way to the trunk. It is preferable to use this fertilizer early in the year, before the first of July, to avoid possible winter injury from late fertilization.

Watering

Most fungous diseases develop and become bad because of moist or wet weather. This is usually beyond the control of the grower. In the greenhouse or on farms where some special irrigation system is used, or where the grower uses a hose out doors, he may be entirely responsible. Just as lack of rain may be a drawback to a good growth of plants, injudicious watering by artificial means—use of too much water or at inopportune times—may prove just as bad by favoring fungous diseases.

Greenhouse men are apt to use water too freely. This is because they have found by experience that free watering at the right time develops the most luxuriant growth and blossoms of certain plants. At the same time this optimism of the grower favors the development of fungi as well, if they happen to be present in the house and especially if susceptible varieties are used. Consequently the wise grower is the one who watches for any signs of disease and who uses water more or less moderately as needed. This is especially true of the use of water on the leaves, particularly when conditions are not favorable for its drying off fairly quickly. Early or late watering on bright days is not so likely to develop sunscorch of the leaves as watering in the heat of the day. Late watering, however, if the water does not dry off during the night, favors infection from fungi. So the season and the time of day, as well as conditions of moisture and air drainage, have to be taken into consideration in watering. In dry summer weather occasional heavy drenching of the soil is apparently better in preventing drought injuries than more frequent light watering.

Seed Treatments

We have spoken about the use of clean seed as a method of securing a crop less likely to develop serious injury by fungi. On the other hand, we do not always know the origin of the seed or its freedom from disease germs; or even if we do know that it comes from a diseased crop we still have need for its use. These conditions give rise to the use of seed treatment to kill the spores or to kill the badly infected and weakened seed.

Treated seed is not so desirable as disease-free seed since sometimes the treatment has not been sufficient or its efficiency has been so great that injury is done to the sound seed itself. The time has not come when treated seed generally is available in the market. The grower of seed rather than the buyer is the one who should know whether or not the seed needs treatment. Usually, however, it is the buyer who treats it for his own protection in growing a subsequent crop. Sometimes the buyer treats seed which does not need treatment and so is not benefited. A good rule is not to treat seed unless it looks suspicious or the grower has had trouble from similar seed that he can trace to a seed-borne disease.

Formalin, hot water, copper sulphate, corrosive sublimate have in the past been favorite types of fungicide for seed (also bulbs, tubers, etc.) treatments. More recently, organic forms of mercury, including various commercial specially-named brands, acetic acid and dusts of various types such as copper salts, mercuric compounds and formalin, are coming into use. The type of the fungicide, the length of treatment and the character of the seed have all to be taken into consideration to secure the most harm to the fungous germs and the least harm to the seed treated. Commercial preparations usually indicate in their literature the method of treatment and the kind of plants to be treated.

Soil Treatments

It is not usually advisable to treat the seed for a disease if the same disease is carried in the soil where it may later affect the seedlings or the growing plant. Hence the need in some cases for soil treatment, especially when the disease is in the soil and is not carried there by the seed. Recent experiments, however, with seed treatments for damping-off troubles, such as Pythium and Rhizoctonia, especially with dusts, seem to indicate beneficial results in preventing these troubles, even, apparently, when the fungi are in the soil rather than in the seed. Perhaps the fungicide adhering to the seed acts as a sort of soil disinfection around the germinating seed for a short distance and thus secures this effect.

The writer believes that for such troubles the best results are secured by fungicides in the soil itself to kill or limit these damping-off fungi. Steam has been used in greenhouses and seed beds, especially tobacco seed beds, for this purpose. The treatment is usually severe enough not only to kill most of the fungi and their spores but also to kill the weed seeds and so help in the matter of weeding. Pans or rakes for enclosing the steam in the soil are used. These usually require a treatment of twenty to thirty minutes and at high enough pressure, 75 to 100 pounds, to force down into the soil six or more inches heat sufficient to cook potatoes buried at that depth.

Formalin has been used to kill fungi in the soil for several different diseases in the state, such as onion smut, black root rot of tobacco, wilt diseases of lettuce and damping-off fungi. While formalin, 1 or 2% in water, is used at the rate of one gallon to half a gallon per square foot of surface of the soil treated, it is, as a rule, not quite so effective as steam. It gives fair results in killing weed seed and is usually effective as a fungicide. When the 1% formalin is used, at the rate of one gallon per square foot, the water has to be applied gradually to allow it to soak into the soil; otherwise the ground becomes waterlogged. A 2% formalin with less water is preferable, as a general rule, because it becomes more quickly absorbed. However formalin stays in the soil so long before it is dissipated that ten days should be allowed before planting seed or fourteen days before setting plants, even when the soil has been stirred later, to facilitate escape of the fumes and thus prevent injury to the plants. Recent experiments with "formaldehyde dust" gave very favorable results.

The writer has not been very successful in treating soil with commercial preparations of organic mercury compounds because of the injury that often results to the plants when the preparation used is strong enough to kill the fungi. On the other hand we have, in flats and beds for damping-off troubles, used various forms of acetic acid with as good results as those obtained by formalin or steam. (See statement under Spinach.) We have also advocated in some cases the use of Bordeaux on the soil and on the plants as they emerge from it as an extra precaution against certain troubles both of seedlings and perennial plants.

Spraying-Dusting

The most familiar practice in preventing fungous troubles is spraying or dusting. A great many fungicides have been used in one form or another as sprays or dusts. The two that stand out as the best and most frequently used are copper and sulphur in various forms. Bordeaux mixture, a combination of copper sulphate and lime in water, one of the oldest fungicides, has proved to be one of the best. On certain plants, however, such as apples and especially peaches, spotting or rusting has resulted and has limited or prevented its use, while on potatoes, cucurbits, grapes, etc., it has not been supplanted by any other spray.

Sulphur as a dust, especially in greenhouses, and later as a spray, and potassium sulphide as a spray are also among the early fungicides. More recently lime-sulphur has been used in orchards especially, and still more recently various forms of very finely divided sulphur, under various commercial names, are gaining prominence both as sprays and dusts.

With any of these fungicides the difficulty is to obtain one that will kill fungous spores and not cause injury to the host. Usage only can determine what will eventually prove the most successful in these respects with different plants.

The third factor of success, besides its fungicidal value and its harmlessness to the hosts, is the ability of the fungicide to stick to the plant tissue to which it is applied. As a rule Bordeaux mixture has been better than either sulphur sprays or dusts in this respect, though with the finer and more recent sulphur products better results are being obtained than formerly. However, it has often been found necessary to use some additional substance to act as a spreader and sticker for the fungicide. This has been especially true with the fungicides that are applied to smooth or glaucous surfaces. Resin-Bordeaux, molasses, oils, various soaps, casein and other substances have been used for this purpose. For small garden and greenhouse work we have found nothing better than a commercial preparation known as potassium-oleate used in paste or liquid form and added in small amounts to the fungicide, especially to Bordeaux.

So far as the chemical factor of a fungicide is concerned, a special one is not necessary for each different disease as seems to be the case with animals. This is apparently due to the fact that a fungicide is valuable only to prevent the germination of spores and their gaining entrance into the plant tissues. The reason some spores are more easily killed than others is due to the greater protection of the walls of some types rather than to any particular difference in the action of the fungicides.

Other factors in successful treatment of plants against fungous attacks relate to the time, frequence and method of application of the fungicides on the tissues of the plants through which infection takes place. The treatments, of course, should start just before and during the time when the fungous spores are active in their germination. This means in some cases spraying or dusting during a limited period; in other cases more continuous treatments; in still others, later treatments. For instance, a dormant spraying just before the buds open is usually sufficient to control peach leaf curl. Dormant and several leaf sprays are necessary to control apple scab on susceptible varieties, while for those not very susceptible to scab less frequent sprayings or dustings usually suffice. To combat apple rust on susceptible varieties, a continuous coating of spray during the period of susceptibility for several weeks on both the emerging and the older leaves and even on the fruit may be required.

The spray should be used on the new growth that is put out during the period of susceptibility and should be renewed as well on the older growth when it has been washed off. Likewise the manner of spraying, that is, how thoroughly it is done, has much to do with success. Successful spraying usually requires good nozzles to thoroughly coat the tissues of the plants and pressure high enough to give a fine mist to settle on all the susceptible surfaces. A drenching that allows the spray to run off is not good.

At the back of this bulletin are given directions for making fungicides. For anyone who wishes general direction for treatment of commercial orchards, both for fungi and for insects, the use of the Station's and the Extension Service's literature on the subject is suggested. In the Station's botanical department, E. M. Stoddard, who has long been interested in the control of fruit diseases and injuries, is always willing to give advice on special and general problems of this nature. In a similar manner, Dr. A. A. Dunlap will give advice on treatments against troubles of vegetables.

DISEASES AND INJURIES OF CULTIVATED PLANTS

ALPHABETICALLY ARRANGED ACCORDING TO HOSTS

Alfalfa

Black mold, *Macrosporium sarcinaeforme.* Apparently this imperfect fungus is uncommon and does not cause much havoc in Connecticut, though in one young field where it was found the seedlings were doing poorly. It is probably the same species as reported here on clover, *q.v.*, although Alfalfa is said to be the host for two other Macrosporiums found in the United States. This one has recently been placed under the genus *Thyrospora.*

Downy mildew, *Peronospora trifoliorum.* This fungus forms a grayish-purple growth on the young shoots and under side of the leaves of *Medicago sativa,* causing the tissues to turn yellow and then brown or purplish before dying. It develops in wet seasons when the plants make a rank growth. As yet it is too rare in this state to be serious.

Leaf spot, *Pseudopeziza medicaginis.* A fungous disease that becomes common on the leaves, first showing as small, brownish-purple spots, is this Ascomycete which forms eventually a minute, disk-like, fruiting pustule on the upper surface of each spot. The leaves turn yellow and often drop off.

In wet seasons it is often serious but there is no very efficient remedy. Cutting fields early rather than late and planting new fields as old ones run out may help.

Rust, *Uromyces medicaginis.* This rust has been found here only twice in alfalfa fields and then it was so scarce that it caused no evident harm. It has been reported on this and other species of Medicago usually further west. Arthur reports the O-I stages as uncertain, though some writers claim the rust is heteroecious with the preceding stages (O-I) on *Euphorbia Cyparissias.* We have found only the II-III stages as small, dusty outbreaks on the leaves, the former light-red and the latter dark-red in color. The rust appears to the writer to be closely related to the red clover rust with which it was associated in one of the fields.

White spot. This shows as numerous white, oval to longer, irregular spots chiefly at upper end of the leaves. It is usually scattered in spots throughout the field. The cause is doubtful but may be due to thrips.

Yellow top. This is usually due to drought conditions or to hot, dry weather of limited duration. It may be furthered by root injury or by type of soil in the field.

Almond (Flowering and Nut)

Brown rot, *Monilia cinerea.* The flowering almond, *Prunus glandulosa,* in late spring may show dead leaves and branches killed by this fungus, often with little evidence of the fruiting stage. Where serious, two or three sprayings with L. & S. or Bordeaux, used in time, should control the trouble. *See* Cherry.

Scab, *Cladosporium carpophilum.* This occurs on the fruit and young stems of the nut-bearing almond, *Amygdalus communis,* rarely grown here. *See* Peach.

Amaryllis

Undetermined trouble. Our only recorded trouble on the plant known as Giant American Hybrid Amaryllis (Hippeastrum sp.) occurred in a greenhouse where complaint was made that a disease injured the flower peduncles so they became one-sided. Purplish-red spots appeared, particularly on the leaves when they reached a considerable size, and especially at the sides and tips, with a yellowish discoloration extending into the normal green tissues. Similar small, discolored spots also showed on the bulbs and the disease may have started from these. While it seemed to be caused by a fungus, we were never able to find a mature fruiting stage to establish its identity. We should like to receive further specimens of this trouble.

Apple

Bitter rot, *Gloeosporium rufomaculans* (*G. fructigenum.*) This trouble of *Pyrus Malus* is not so important here as it is farther south where it is often very destructive. With us it causes occasional rotting of the ripening or stored fruit but has not been seen in cankers on the limbs. The rotted tissues show the characteristic, sticky or dried, pinkish, concentric spore masses. The Gloeosporium stage is formed in a somewhat similar manner on a variety of other hosts: those noted here are apple, currant (red and yellow), grape, horsechestnut, Palm, pepper, privet. The mature stage, a sac-fungus known as *Glomerella cingulata,* on certain of its other hosts sometimes appears later than this conidial stage.

Ordinary spraying takes care of the trouble here.

Black rot. *Sphaeropsis malorum.* Black rot causes the maturing fruit to turn brown, then black with more or less evident spore pustules. On the leaves it forms small, brown spots and on the branches, dead areas or cankers. It also occurs on a great variety of hosts, chiefly on the branches, often as the result of winter or other injury. Besides on the apple, we list the fungus here on oaks, pear, pine and quince. Its asco stage, found on the dead tissues, has been determined as *Physalospora Cydoniae.* We have not yet found this stage.

Besides the hosts on which this fungus has been definitely listed here, we have collections of Sphaeropsis on the following hosts: *Amygdalus Persica, Crataegus Oxyacantha, Hedera helix* (determined by Thaxter as *Sphaeropsis hedericola*), *Morus alba* (called *S. Mori* by some), *Ulmus americana,* (also called *S. Ulmii* or *S. ulmicola*) and *U. pumila,* on the branches of all except Hedera on the leaves. On these specimens, the fungi seemed to have been acting as saprophytes rather than as parasites, but further study as to their nature and identity is needed. *See* also Walnut.

With fruit trees, we recommend spraying as for scab and with these and other trees the removal of all injured and dead branches.

FIGURE 13. Apple European Canker

FIGURE 14. Apple Scab.

FIGURE 15. Apple Sooty Blotch

Blister canker, *Nummularia discreta.* This trouble was first called to the attention of orchardists by Hasselbring in Illinois in 1902 while the writer was working with him on apple diseases. We have never certainly run across it in Connecticut. Thaxter in March, 1889, collected specimens at Greens Farms, although he did not mention it in his Reports. This fungus is said to be rather serious in some orchards, especially in the Mississippi valley, and to cause somewhat sunken, reddish-brown cankers in the bark from which in time there may break through the evident, saucer-shaped, fruiting bodies, about a quarter of an inch in diameter, of this Ascomycete.

Brown rot, *Monilia cinerea.* This occurs occasionally on ripened fruit. *See* Cherry.

Crown gall, *Bacterium tumefaciens.* It is seen on nursery stock; apparently it does little damage in the orchards. *See* Rose.

European canker, *Nectria galligena. See* Birch. (Fig. 13).

Fire blight, *Bacillus amylovorus.* Apparently this bacterial disease is not so bad here as in some regions. It confines itself chiefly to killing young twigs in late spring and early summer. In a few cases it has been seen on the ripening fruit. *See* Pear.

Fruit spot, *Phoma pomi,* makes small, dark-colored spots in the skin of the fruit and in light skinned varieties often shows a reddish border. In wet seasons it may be bad and extra later sprayings be required, as for scab, for its control.

Heartwood rots, *Fomes igniarius, Hydnum septentrionale, Pleurotus ulmarius, Polyporus admirabilis, P. galactinus, P. spumens.* In the well tended orchards, heartwood rots are not serious, but in neglected orchards often the whole interior of the tree is destroyed by one or another of the above, large Basidiomycetes. The fruiting stage, however, is not always found.

Where necessary, the owner should clean out the decayed wood and allow proper drainage and ventilation, or if desired, seal tight with some recognized cavity filler.

Powdery mildew, *Podosphaera leucotricha.* This mildew is apt to be present in nursery and young or neglected orchard trees. It coats the leaves and twigs with a more or less evident, white felt of mycelium and summer spores in which eventually the asco stage may appear as small, embedded, blackish bodies. Where necessary, give several sprayings, beginning on the dormant trees in the spring.

Rusts, leaf, *Roestelia pyrata, R. globosa.* The former is by far the most common leaf rust here; the latter is described under Hawthorne, *q.v.* The common rust forms more or less conspicuous, orange-yellow spots on the leaves on the under side of which, from July on, the fruiting stage shows as clustered cups containing the powdery, brownish spores. These cups split open with reflexed, fringed hairs at the edges. The fruit occasionally shows yellow-green infection spots that may or may not produce fruiting cups. Certain varieties of apples, as Wealthy, are very susceptible to this rust, while others, as Baldwin, are nearly exempt. The mature stage is found on the cedar, *q.v.*, known as "cedar apples" and is called *Gymnosporangium Juniperi-virginianae.*

If necessary cut down the infected cedars around the orchard; the spores from these are, however, carried long distances. Spraying is not entirely effective but if deemed necessary the leaves should be thoroughly and continuously coated from their first appearance until the very last of June.

Rust, stem, *Roestelia aurantiaca.* This is found rarely on young twigs. *See* Quince.

Scab, *Fusicladium dendriticum.* On the fruit this fungus shows as olive-black, scabby spots rupturing the skin and causing the fruit to be stunted or misshapen. On the leaves the scab shows as spore-bearing, olive threads radiating from a central point and eventually producing brown, dead spots that may cause defoliation. On very susceptible varieties, it can carry over on the twigs as more or less inconspicuous pustules and infect the new leaves. The mature stage, *Venturia inaequalis,* develops on the dead leaves in the spring and causes primary leaf and blossom infections. It is worst here on McIntosh, Fall Pippin, is often bad on Greening, and is least injurious on Baldwin and Russet.

On susceptible varieties, spraying may be necessary on the dormant trees and repeated as pre-pink, pink and calyx stages with one to three subsequent leaf and fruit sprays as required according to weather conditions. **(Fig. 14).**

Sooty blotch, *Gloeodes pomigena (Phyllachora pomigena).* This is a superficial fungus that is produced usually late in the season on the fruit, showing as blackish, round blotches that can be more or less removed by wiping well with a cloth dampened with vinegar. It is most evident and common on light skin varieties and is also found on the pear. Except in a wet season orchards well sprayed suffer little, especially if late spraying is carried on. (Fig. 15.)

Sooty mold, *Fumago vagans.* Under this name we classify the black, superficial, saprophytic fungus that appears on apple leaves when honey-dew from aphids is present. It is also found under similar conditions on the leaves of other trees, shrubs and herbs. Complaints have been made of its marring appearance on linden, maple, pear and greenhouse tomatoes especially. It is probably connected

as an imperfect mycelial and conidial stage (*Cladosporium, Macrosporium*) of the Capnodium fungi, reported here also as following honey-dew, on Tulip tree and White Pine, *q.v.*

Storage and Drop rots, *Alternaria* sp., *Botrytis cinerea, Cephalothecium roseum, Fusarium* sp., *Penicillium expansum, Phytophthora cactorum* (*See* Pear), *Rhizopus nigricans, Volutella fructi.* These troubles occur on drops under the trees and in apples in storage in addition to the fruit rots already described. They mostly occur on apples in storage not properly sprayed or stored under poor conditions, although all the fruit as it reaches over-maturity may develop a rot, especially out of cold storage. Penicillium is perhaps one of the most common causes in the latter case.

Baldwin spot (Bitter pit). This trouble occurs on different apples but here it is most common on the Baldwin. It shows in the flesh of the apple as small, dry, brownish spots of more or less collapsed cells and occurs most frequently near the surface and blossom end but in bad cases reaches deeply inward and upward. At first these spots may not be evident on the surface but are revealed on cutting the apple open. If abundant, they give a somewhat bitter taste when the apple is eaten. Eventually the trouble may show as discolored, somewhat sunken spots in the skin. Individual trees under certain conditions develop the trouble more than others. Drought is said to be a factor by some. Possibly injury by insects, such as the rosy aphid, when the fruit is growing, may cause this or similar injury. In certain varieties very similar injury by the railroad worm needs to be distinguished. (Fig. 16.)

Fasciation. We have seen these flattened growths only once on this host, but in this case with very short and recurved tips of a young branch. We thought it to be due to winter injury of the buds. *See* Asparagus.

Frost injury. There are several kinds of late frost injuries found here. The twigs and leaves may be injured more or less severely, or the latter may be crinkled and thickened and the skin be separated from the tissues beneath. The blossoms may be killed, moderately or generally according to the stages of development, or just the pistils or stamen may suffer. If the fruit is set, it later may develop scabby bands where the water settled and froze on it.

Hail injury. Severe hail storms late in the summer occasionally cause serious injury to fruit orchards especially on the more tender varieties. The hail stones often produce deep, sunken spots where they hit the fruit, causing it to become unsightly or even knocking it off the branches. They also open the way for rot later on. On the stems the stones bruise or break the bark and later on the healing-over gives the effect of small cankers. These may be mistaken for other injuries if one is not aware that the storm occurred over the orchard.

Mice girdle. In winter when snow covers the ground rather deeply or continuously, girdling by field mice is not uncommon. The tender bark at the base of trees and shrubs of various kinds is eaten. Where nests are made in the refuse around apple trees, the girdling sometimes extends all around the tree and up to the top of the snow line, as high as two feet. Complete girdling eventually will kill the tree by starvation.

Bridge grafting with twigs long enough to extend from the lower to the upper bark cambium, if done in time, usually will save the tree.

Mosaic and Chlorosis. The former usually shows as lighter and darker streaks between the side veins of the leaves, especially at the tips. It has been described as a trouble caused by leaf hoppers but does not seem to be perennial here on affected trees, so its nature as a true mosaic rather than as an insect injury is in doubt. A more definite trouble, which we call chlorosis, showing as irregular, whitish spots in the normal green leaves, is seen occasionally on isolated branches. Rarely we have found this abundant on single trees, especially evident on the lower branches. The cause of this trouble has not been determined and although certain trees seem to be more subject to it, they do not show it yearly to the same marked degree. Some deficiency of definite chemical elements in the soil, or of the power of the tree to obtain them, seems to be the most probable explanation, although late frosts may be the cause.

Scald. This is a term applied to injured apples (and other fruits) that have been held in cold storage under conditions of temperature, moisture, etc., unfavorable for their best preservation. Also its appearance may have been favored by other conditions before the apples were placed in storage. It becomes evident in the market soon after the apples are removed from storage through the brownish discoloration of the skin. Under ordinary farm-storage it also sometimes appears.

The U. S. Department of Agriculture has made a special study of this subject and has literature on its cause and prevention.

Spray injury. We have yet to find the perfect fungicide, as regards killing fungous spores before their germination and at the same time preventing injury to the sprayed or dusted host. Injuries to the host vary with different fungicides and in different climates, different seasons and times of applications. Too high pressure pumps or certain nozzles and guns may increase the trouble. The apple is not so sensitive as the peach either to injury to its leaves or twigs but varies according to varieties as regards leaf and fruit injury. So orchardists get burning and spotting of the foliage with more or less defoliation and varied misshapening and especially russeting of the fruit. Many fungicides have been rejected as unsafe or useless, while others after long usage, as Bordeaux, have largely disappeared except for certain treatments or in restricted localities. Even L. & S. has met with objections from some growers under certain weather conditions. Addition of lead arsenate and other ingredients have complicated or increased the injury. Occasionally spray injury is greater than the good accomplished by killing fungi or insects. Gradually through experience the grower finds what will best suit his needs with the least average injury of this kind. (Fig. 17.)

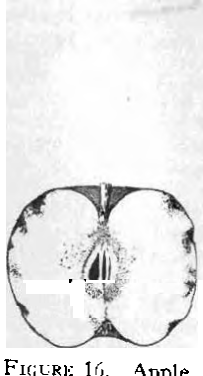


FIGURE 16. Apple Baldwin spot.

FIGURE 17. Apple Spray injury.

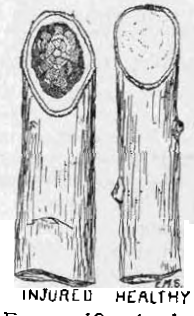


FIGURE 18. Apple Winter injury.

Sun scorch. Exceptional hot weather produces wilt and death of the leaves and scorch on the exposed side of fruit and bakes apples on the ground. Injury often follows showers or spraying on hot days, especially in the middle of the day. Similar injury we have seen on gooseberries, tomatoes, eggplants and peppers.

Water core. This shows usually only in certain varieties, as King and Pound Sweet, and is worse in wet seasons with a variable growth of the fruit. The apple shows a watery condition of the tissues beginning at the core and reaching outwards for a variable distance.

Winter injury. Severe winters, especially when the temperature falls below zero for a few days and when there is lack of snow mulch, produce various injuries to trees. Warm winter weather followed by sudden cold, a late growing fall with a sudden severe drop in temperature, too early a start of growth in the spring, all result in certain types of injury. Wet spots in the soil give rise to root injuries, as do lack of snow or other mulch in wind swept areas. Too late fertilization of nursery and orchard trees, putting them into winter in an unripened condition, is also responsible for wood, twig and bud injuries. Severe injury to the sap wood may show by its blackened condition changing it prematurely into heartwood.

Injury to branches and twigs may result in their sudden or premature death. Bark may be killed at the base of the tree and a girdle or cankers, of various sizes and shapes on different sides of branches, may result. These are sharply marked off by cracks from the living bark but later are sometimes mistaken for a fungous injury when saprophytes or weak parasites in fruiting stages appear on them. (Fig. 18.)

Apple Mint

Rust, *Puccinia Menthae.* This rust is reported here as new to the host, *Mentha rotundifolia,* in the State as well as in the United States. *See* Beebalm.

Ash

Anthracnose, *Gloeosporium aridum.* Anthracnose is an occasional trouble of *Fraxinus americana* but it may in wet seasons become locally prominent. It causes a wilting and death of the foliage or a light-brown discoloration of certain areas of the leaves. *See* Anthracnose of Sycamore for treatment.

Leaf spot, *Piggotia Fraxini.* This shows as small, purplish specks on the upper surface of the leaves with the fruiting stage scattered all over the lower side as minute, black bodies. It is not so important or common as usually to require treatment.

Rust, *Aecidium Fraxini.* The rust not only attacks the leaf blades, petioles and young twigs but also occasionally the winged fruit. The cluster cups project above the more or less swollen tissues as small, aggregated receptacles, toothed at the edge and filled with orange-colored spores. Early wet weather favors its development, as it comes from a mature stage known as *Puccinia fraxinata* on marsh grass. As it is annual on the ash and varies greatly with different seasons, spray treatment is hardly advisable. It usually seems to be worse along the sea shore.

Cankers, etc. *See* Addenda for details.

Asparagus

Anthracnose, *Colletotrichum* sp. We have seen this rarely on the mature stalks of *Asparagus officinalis* showing as irregular, often elongated, areas of a gray color in the normally green tissues and producing numerous, small, black fruiting pustules.

Rust, *Puccinia Asparagi.* Rust was formerly a very bad parasite on the leaves and stems of asparagus. It begins as semi-dusty, reddish-brown pustules of the summer spores and later these develop the black, firmer pustules of the winter stage. The cluster-cup stage has rarely been found here at the base on the recently cut stems in the spring. With the introduction of the resistant or semi-resistant strains of the Washington types about twenty years ago, rust became much less common. Recently, however, it apparently has become more common on some of the semi-resistant strains. The best of the resistant varieties only should be planted and, if they or the susceptible ones gradually become infected, late in the fall the tops should be cut and burned to prevent general spring infection from the mature or winter spores. (Fig. 19.)

Fasciation. *See* Addenda for information in detail.

Frost injury. Occasionally late frosts, occurring after the asparagus shoots begin to show above ground, kill the earliest ones, as shown by whitish, soft tips that finally rot through saprophytic fungi. Below the ground, the tissues may be firm and uninjured. A loss of 10% has been noticed in small plots.

Smoke injury. We have heard of a few cases of injury from brick kilns where law suits have resulted. *See* Grape.

Aster

Gray mold, *Botrytis cinerea.* Under moist conditions this semi-parasitic fungus causes more or less rot of the leaves, flowers and young stems. *See* Geranium.

Powdery mildew, *Erysiphe cichoracearum.* This mildew has been found rather common on various species of wild asters and occasionally on some of these when cultivated. *See* Phlox.

Rust, *Coleosporium Solidaginis.* While this rust is very common on wild goldenrods and asters and occasionally on these in cultivation, it has been seen here on the China Aster, *Callistephus chinensis,* and recently on the rock aster, *Aster alpinus.* The summer stage shows as small, dusty, orange outbreaks of spores and the mature stage in late summer and fall as firm, larger, orange blisters. The spores of the latter soon germinate in position and infect the needles of certain pines, *q. v.,* which in the spring produce the cluster cup stage known as *Peridermium acicolum.* While the rust on the pines is annual, on certain of the perennial herbaceous plants it may appear each year by late fall infection, through its II spores, of the roseate leaves on the ground that carry over the winter. The III spores apparently are only for infecting the pine needles and the I spores on the pine needles only for infection of the alternate (Asters, etc.) hosts.

Stem rot, *Fusarium* sp. So many species of Fusarium are now described, often occurring on the same host, that one is in doubt what to call the species when found. Anyway we find a Fusarium rotting the stems and main roots here of various herbaceous plants and cuttings as well as on asters. Too much water or injury at the base is frequently the cause of the fungus getting a start in the young, unhardened tissues.

Stirring the soil to obtain a dry mulch, aided by some lime or sulphur dusted at the base, may help to keep infection from starting. The destruction of infected plants as soon as they appear and rotation each year to a new plot of ground may help to lessen this trouble. Also the grower must be careful in the use of manure. Obtain resistant strains of the aster if possible.

Nematode rootknot, *Heterodera radicicola.* *See* Cucumber.

Yellows. This host was the first on which "yellows" was found. Sturgis of this Station was one of the first to mention the trouble. It is now known on a large number of plants; here we have listed it only on aster, calendula, dahlia, and strawflower, but it is also found on certain weeds, as ragweed. The symptoms in general are the yellowed foliage with frequently distorted or one-sided blossoms. True yellows should not be confused, however, with the yellowing of leaves caused by dry weather. It has been shown by Kunkel that a leaf hopper carries the "virus" from diseased to healthy plants, thus spreading the disease. The nature of the virus, like that of mosaic, is unknown.

One should remove and destroy all "yellows" plants as soon as they appear, also rotate yearly and prevent, where possible, the presence of leaf hoppers. Some experimenters claim good results in keeping out leaf hoppers by growing asters under cheesecloth tents (22 x 22 threads per inch) and rogueing out any suspicious plants as they appear.

Azalea

Leaf curl, *Exobasidium Vaccinii.* This fungus is common on members of the Heath family, especially in nature on blueberries, etc. Occasionally it forms more or less cup-shaped thickenings in the leaves. Usually it infects a cluster of leaves as well as the young shoots, that when young are pinkish tinted but become covered with a white bloom when spore formation takes place. On certain hosts, as Lyonia, it forms large green galls, formerly considered as a distinct species, known as "swamp or honeysuckle apples". These at first, are rather solid and sour but later become larger and less compact. The fungus is one of the simplest forms of the Basidiomycetes or the toadstool group.

Apparently no treatment for control has been given by experimenters but a late dormant spray might prove of benefit if needed.

Powdery mildew, *Microsphaera Alni.* *See* Lilac.

Rust, *Pucciniastrum Myrtilli.* Like the leaf curl this fungus has a large number of wild hosts in the Heath family in its II and III stages. On cultivated Azaleas it has been found here on *A. nudiflora* and *A. viscosa.* The II or summer spore stage occurs as small pustules on the under side of the leaves which discharge

orange-colored spores, while the later III stage is more permanently embedded in the leaf tissues and easily overlooked. The I or cluster cup stage occurs on the needles of the hemlock, *q. v.*, and is known as *Peridermium Peckii*.

Keep the azaleas away from the hemlocks to prevent infection, which takes place in the spring and early summer.

Barberry

Anthracnose, *Gloeosporium Berberidis.* In midsummer of wet seasons the leaves show a brownish, dead area at the tips and margins, separated from the normal green tissues by a purplish border, but sometimes the entire leaf is involved. The inconspicuous fruiting area occurs beneath. No permanent damage is done except to the leaves of the season involved.

Rust, *Aecidium Berberidis.* This is the common I or cluster cup stage of the rust that the farmers of England pointed out (and later deBary proved) was connected with the II and III stages of wheat rust, *q. v.*, then known as a distinct species, *Puccinia graminis.* The leaves of *Berberis vulgaris* in the spring show yellow spots in which above are minute, black dots that ooze out spore-like bodies of uncertain function. Later on the underside of the leaves appear the clustered, toothed cups in which yellowish spores spread the rust to various grasses and grains thus proving that this rust, like many others since reported, is parasitic on two distinct types of hosts (heteroecious).

In the west, government and state control aim to lessen the spread of the black stem rust in grains by the destruction of the barberry (except resistant Japanese) in that region. *See* Timothy.

Seedling rot, *Rhizoctonia Solani.* This was prominent one year in a nursery where acid peat moss was used as a fertilizer on the seedlings. *See* Spinach.

Wilt, *Verticillium alboatrum?* Nurserymen have complained to the inspectors of a trouble in certain fields of Japanese barberries, *Berberis Thunbergii,* that often killed the plants prematurely, usually showing a wilting of the leaves or a turning yellow and falling off. We have occasionally seen such a trouble in hedge rows in the city but with no evident signs of a definite fungus acting as the cause; so we have thought of it as the probable result of winter injury. Recently Dr. McCormick investigated the stems of certain sick specimens and found evidence of a Verticillium. This seemed to be the cause in this and probably in some other cases, since obscure root and stem troubles of various plants are being laid more and more to species of Verticillium. Whether or not any species or strain other than the one named here questioningly is involved for the different hosts, further study should finally determine. So far we have listed black raspberries, maples, potatoes and snapdragons as other plants having wilts caused by Verticillium. The species *V. alboatrum* has been definitely named as a cause of wilt of Japanese barberry in New York.

Leaf scorch. Scorch appears in dry or hot seasons causing leaf damage much like that of anthracnose from which it can only be distinguished by the absence of the fungus.

Barley

Powdery mildew, *Erysiphe graminis.* This is common in wet seasons on *Hordeum vulgare. See* Rye.

Rust, leaf, *Puccinia anomala.* The II stage occurs as small, orange, dusty outbreaks on the leaves (chiefly), while the III stage is lead colored and more permanently embedded in the tissues. Its cluster cup stage has never been found here, though it occurs in Europe on Ornithogalum; so the rust apparently carries over through its II stage here or further south. Its damage is chiefly to barley grown for green fodder and no control is attempted.

Rust, stem. *Puccinia graminis.* The stem rust is not frequently found here. *See* Wheat.

Smut, covered, *Ustilago Hordei.* This smut forms more permanent, blacker outbreaks filling the heads of the grain than the next smut. It responds to dusted and wet seed treatment but the injury here is so little that no control is attempted.

Smut, loose, *Ustilago nuda.* The loose smut also shows in the heads but as a more dusty, olive-black spore mass that is sooner disseminated, leaving behind the naked, hard plant tissues. The two smuts are sometimes seen together in the field in about the same amount. This smut seems to require more thorough or modified seed treatment for control since the smut infects the tissues of the young grain in the field in the same way as does the loose smut of wheat. (Fig. 20.)

FIGURE 19. Asparagus rust

FIGURE 20. Barley smut.

FIGURE 21. Bean (Lima) Downy Mildew.

Stripe, *Helminthosporium gramineum.* We have collected this fungus twice, both times in July, 1926. It is apparently not serious in this state. Both specimens show elongated streaks of dead tissues chiefly along the midribs of the leaves. Other species of this genus have also been reported on this host but this is the name we have selected for our specimens. *See* Black mold under Timothy.

Beans, Lima

Bacterial spot, *Bacterium Vignae.* This is usually a smaller and a more definite spot disease than the blight of string beans. It occurs on the leaves first as small, reddish spots that later may run together as a larger spot with a brownish center (which may eventually crack away) and a purplish-red border. Sometimes a yellow halo surrounds the spots. The infections develop also on the pods and the bacteria may occur on the seed and so carry the disease to new fields. It varies according to seasons, being worse in wet ones. This disease has also been found once on cowpeas at the Station farm. If necessary, one should treat the seed, or use the best seed only, and rotate the fields.

Downy mildew, *Phytophthora Phaseoli.* The very characteristic downy, white felt of mycelium and summer spores is best seen on the older, infected pods of *Phaseolus lunatus.* While the leaves and young blossoming stems may be infected and killed, the growth is not so conspicuous on them. The mycelium enters the pods and seeds and produces under certain conditions the characteristic, round spores that carry the fungus over the winter. It requires a moist season in July and August to get a start and so it is quite variable in its appearance. Most years there is little or no damage but occasionally it is severe. *See* Rept. 1905:278–303. (Fig. 21.)

For control the grower should rotate the crop, use drier rather than moist soils and, if the disease gets an early start, should begin at once to spray with Bordeaux and continue as long as needed.

Leaf-Pod spot, *Phoma subcircinata.* We have seen this rarely and then only on the leaves. It produced large, semicircular to irregular, brownish spots often with a reddish border and more or less evident rings of growth. In these spots the fruiting stage is embedded as small, black bodies. In time the tissues cracked and wore away. So far there is no need for treatment.

Powdery mildew. *Erysiphe Polygoni.* It has been found only in the conidial stage and usually not very prominent. *See* Clover.

Arsenical burn. We have seen cases, in the past when Paris green was more in evidence and was used on the soil to kill chewing insects, of burn resulting where care was not used in keeping it away from the leaves and base of the plants. The remedy is evident.

Mosaic. This is similar to the mosaic of other vegetables. *See* Cucumber.

Beans, String

Anthracnose, *Colletotrichum lindemuthianum.* Anthracnose shows on the leaves and especially on the pods of *Phaseolus vulgaris* as usually round, brown spots with a reddish border. It may be mistaken in some cases for the bacterial blight but the presence of the more or less evident, pink spore-masses helps to identify it to the naked eye. Here it is quite variable in different seasons as well as on different varieties. As it is carried over in the seed, as well as on the refuse, it gains entrance to the new crop in this way. The young seedlings are often killed or badly injured. Shear made artificial cultures of this imperfect stage and in them were produced the asco stage which he calls *Glomerella lindemuthianum.* We have never found this stage in nature. (Fig. 22.)

Seed treatment and spraying have not proved entirely satisfactory where the crop is grown on a large scale. Rotation and selection of good seed, especially of resistant varieties, probably in the long run prove the most practical methods of control.

Bacterial blight, *Bacterium Phaseoli.* This is somewhat like the bacterial spot of the Lima bean but the spots are more likely to run together and merge into extended areas involving the whole or a large part of the leaf. When wet, the thin, infected tissues have a semi-pellucid, water-soaked condition. Apparently some of our herbarium specimens identified under this name also include *B. medicaginis* var. *phaseolicola* since yellow-halo spots show on some of them. From the number of species of bacteria that have been listed on this host, we are inclined to believe that plant bacteriologists have overdone the matter.

Treatment is the same as for the bacterial spot of the Lima bean. As this trouble is much more injurious than on that host, care in weeding out the young plants in the field early in the season might prove helpful, as well as the selection of the most resistant varieties to start with.

Bacterial wilt. *Bacterium flaccumfaciens.* This wilt has appeared here occasionally and might be mistaken for sun scorch. It has been recognized only on the young plants and especially when they were exposed to strong sunlight and apparently when planted in a favorable time and location for the disease. The leaves wilt down and sometimes the whole plant dies without any very evident external sign of the cause. Cutting across the stem or main veins, however, frequently reveals a milky exudation which shows that bacteria have clogged or injured the vascular system and thereby cut off the water supply to the healthy tissues above, thus resulting in their wilting and death.

Damping-off, *Pythium debaryanum, Rhizoctonia Solani.* The second fungus has also been found injuring the roots and base of young field plants as well as seedlings. *See* Spinach.

Leaf blotch, *Isariopsis griseola.* This is a saprophyte or weak parasite that appears on plants grown under rather unfavorable conditions of crowding, dampness, etc. The leaves develop irregular, brown spots in areas on the under side on which appears a more or less even growth of erect, black fruiting threads, bearing at their summit a grayish, bushy group of spores.

Leaf spot, *Phyllosticta phaseolina.* The spots caused by this fungus are darker, circular, with more or less evident concentric marking of growth and show embedded, small, black fruiting pustules. It is even less common than blotch.

Powdery mildew, *Erysiphe Polygoni.* Usually this forms a somewhat scanty growth, of the conidial stage only, on the leaves. *See* Clover.

Rust, *Uromyces appendiculatus.* The bean usually injured here by this rust is the Kentucky Wonder. The II stage shows on the leaves and pods, usually abundant, as small, dusty, reddish-brown outbreaks; later the III stage is similar but of a dark-brown color. The I stage has been seen here rarely, and then on young plants, earlier in the season, as white cluster cups and spores, the former usually few in number.

Where troublesome, restrict the planting to the more resistant varieties or select seed only from plants known to be free from the rust the previous season and plant in new soil.

Mosaic. This trouble occurs fairly frequently but usually is not serious as it is generally confined to a few plants. *See* Cucumber.

Sun Scorch. In certain years when hot sunshine follows a shower, we have seen a sudden and severe scorch of plants that otherwise gave no clue as to the cause of the trouble.

Beebalm

Rust, *Puccinia Menthae.* The common rust of mints in nature has been found here on cultivated species of *Monarda didyma, M. fistulosa, M. Kalmii, M. Ramaleyi* as well as on species of Mentha. The infections show the II and III stages chiefly on the under side of the leaves as small, light or dark-brown, dusty pustules usually very abundantly. They cause a more or less definite spotting of the upper surface. We have found the I stage that sometimes occurs earlier on the same hosts only twice, once each on peppermint and spearmint, *q.v.*

In the fall after the plants die above the ground, cut off and carefully clean up all remains of the same to destroy the spores. If this fails, also spray the plants and ground a few times with Bordeaux as the plants start to develop in the spring.

Beech

Anthracnose, *Glocosporium Fagi* var. *americana.* Occasionally in favorable wet seasons, this trouble has been seen on the leaves of cultivated beech trees, especially the copper beech, as irregular, light-brown areas reaching inward from the edges or as isolated spots within the normal green tissues, upon which the embedded fruiting stage is more or less evident.

Gas injury. We have seen one case where this injury was evident on all of the leaves, showing as more or less extended dead areas inward from the margins and causing partial defoliation. Similar trouble has been found on Maple.

Leaf scorch. This trouble is more variable but very similar to the preceding. *See* Maple.

Lightning injury. A Copper beech was badly injured by lightning, but continued to live despite the bark at the base being entirely girdled except a small connection at one side with a large healthy root. Proper pruning of the dead and dying branches eventually produced an equilibrium for water supply above and food to the roots at the base.

Beet

Damping-off, *Pythium debaryanum, Rhizoctonia Solani. See* Spinach.

Drop rot, *Sclerotinia sclerotiorum.* We have seen this on young plants in seed beds. *See* Lettuce.

Leaf-Root rot, *Phoma Betae.* As compared with the leaf spot below we have seen this only rarely, on the leaves of *Beta vulgaris.* It shows as conspicuous, round to irregular, at first yellowish, spots with rather faint, concentric growth-markings. The embedded, black fruiting bodies are most evident on the upper surface. We have also had seed that dampened off in the germinators rather badly, thus showing how the fungus carries over on them to infect new crops. We have received no complaint, as yet, of the dry rot of the matured roots. Select the best seed and if necessary treat it to kill that which is badly infected.

Leaf spot, *Cercospora beticola.* On this host the leaf spot is quite common; *see* Chard.

Root rot, *Rhizoctonia Solani.* This occurs very often in greenhouses as a damping-off trouble similar to Pythium but sometimes it also causes injury to more mature roots. *See* Potato.

Scab, *Actinomyces scabies.* This trouble is not uncommon but usually less injurious than the same scab on potatoes, *q.v.*

Prematuring. In some years, as in 1924, seedling beets premature and some go to seed the first year. *See* Lettuce.

Begonia

Nematode leaf blight, *Aphelenchus olesistus.* This trouble is due to minute worms, known as eel-worms, related to the rootknot species that is common on roots of various hosts. This leaf species is slender enough, especially when young, to enter the leaf through the small openings or water pores of the epidermis. In the large chambers beneath these, they live and reproduce and the young spread the injury through connecting openings or again through the water pores to better locations. Of course they gain food from and cause injury to the invaded plant tissues. (Fig. 23.) The infected spots change color and enlarge so that eventually considerable portions of the leaf are involved. The main veins lessen the rapid spread of the injury and mark it off from the healthy tissues. *See* Rept. **1915**:455.

FIGURE 22. Bean (string) Anthracnose.

FIGURE 23. Begonia Nematode leaf blight.

FIGURE 24. Blackberry Orange rust.

Water should be kept off the leaves to limit the spread of the trouble and old badly infected leaves should be destroyed. Infected plants should be given plenty of space and kept from contact with the healthy. In Europe growers claim to help the plants by dipping them in hot water for two to several minutes.

Nematode rootknot, *Heterodera radicicola.* This other nematode trouble has also been found here on the roots of greenhouse plants. ***See*** **Cucumber.**

Bellflower

Rust, *Coleosporium Campanulae.* This is very closely related to the pine-goldenrod leaf rust. The orange outbreaks of the II and III stages have been found here only on leaves of cultivated *Campanula rapunculoides.* The I stage on pine needles is also similar to the species just mentioned but has not been found here.

There is no question, however, that the rust can carry over through the II stage on the bellflower, so the parts of all infected plants above ground should be destroyed in the fall. *See* Aster and Pine.

Birch

European canker, *Nectria galligena.* This fungus produces a conspicuous, central deep canker with concentric, shallower rings of growth that are gradually killed back at the edges. It occurs on the apple and some other trees but is especially bad on the wild sweet birch, *Betula lenta* and less so on the paper birch, *B. papyrifera* and grey birch, *B. populifolia.* The fruiting stage shows more or less abundantly (sometimes it is even missing) as scattered or grouped, red bodies like insect eggs that produce the winter spores. It is listed here also in apple, hornbeam and oaks.

Cut off and burn the infected branches of badly injured trees.

Rust, *Melampsoridium betulinum.* This rust so far has been found only on the various wild species of birch, chiefly on ***Betula populifolia.*** It forms yellowish, more or less dusty, pustules of the II stage on the leaves and is rather common, especially in the northern part of the state. The III stage is not so common and is difficult to detect, apparently occurring on the leaves very late in the season. The I stage, with inconspicuous cups, probably occurs on the leaves of the larch in our swamps but so far we are not certain whether those collected belong to this rust or to the rusts on willow and poplar. There is some evidence to indicate that the rust sometimes carries over through the II stage.

Bittersweet

Crown gall, *Bacterium tumefaciens.* This is seen occasionally in the nurseries on *Celastrus orbiculatus.* *See* Rose.

Chlorosis. The yellow and white spotting, or the more common yellowing, found on the leaves of native plants of *C. scandens* may be due to insects or late frosts.

Blackberry

Crown gall, *Bacterium tumefaciens.* This is not uncommon on roots of individual plants in a patch of Rubus sp. but does not seem to be serious. *See* Rose.

Leaf spot, *Septoria Rubi.* This spot is common on various species of blackberry, dewberry and raspberry, both cultivated and wild. It shows as small, round, white to brown spots with an evident purplish border not only on the leaves but also on the young stems. The summer spore stage is parasitic on these showing as embedded black spots; the winter stage is said to develop later as a saprophyte and is an ascomycete, known as *Mycosphaerella Rubi,* which as yet we have not found. The trouble is usually not serious enough to warrant spraying.

Powdery mildew, *Sphaerotheca Humuli.* So far this mildew has been found only sparsely in its conidial stage. *See* Rose.

Rust, *Kuehneola albida.* This autoecious rust, in its II stage with much smaller pustules than the next rust, occasionally becomes conspicuous on the leaves of the cultivated blackberry. The characteristic white pustules of the III stage are not so abundant as on the wild dewberry, *R. hispidus,* which may be the source of infection. However, raking up and burning the leaves in the fall may serve to lessen the trouble.

Rust, orange, *Caeoma nitens.* On the cultivated blackberry we apparently find only this short-cycled form causing the injury. The large, dusty, orange outbreak of the aecia on the underside of the leaves is the only stage. Their spores combine the functions of both the summer and winter spores. As the fungus is perennial in the underground parts of the plant, the only remedy is to pull up and destroy the infected plants as they appear. (Fig. 24.)

Mosaic. This disease is less evident and injurious than on the raspberry, *q.v.*

Winter injury. There have been some complaints but this trouble is less likely to occur than on the raspberry.

Blueberry

Leaf curl, *Exobasidium Vaccinii.* This is much more common on the wild blueberries, huckleberries, Vaccinium species, etc., than on the cultivated Azalea, *q. v.*

Rust (Hemlock-Blueberry), *Pucciniastrum Myrtilli.* This is common on various wild species of the heath family but also has been found once on the cultivated black blueberry. *See* Azalea.

Rust (Witch's Broom), *Calyptospora columnaris.* Both the wild, common, low and high blueberries occasionally develop this perennial rust in the northern part of the state. The III stage only is present and it forms chestnut-brown swellings on the young shoots which are often clustered together into a witch's broom effect. The embedded spores germinate in position and infect the leaves of the balsam-fir which is very rarely found in our northern woods, but grows still farther north.

Box

Canker-Wilt, *Volutella Buxi.* While this trouble of *Buxus sempervirens* occurs here, I think that sometimes winter injury is mistaken for it. It causes cankers on the stems and a wilting of the leaves. The latter may be directly attacked also. The fruiting stage is more or less evident as pinkish exudations on the injured parts. When it is bad the stems are killed. In any case where trouble of this nature occurs, the badly injured and dead branches should be cut out and burned and the surrounding branches sprayed with oleate Bordeaux.

In the early summer of 1932 there was called to the writer's attention certain box plants in a New Haven yard that were losing their leaves and many of whose branches were dying. They were in two rows bordering a walk and the previous fall certain of them had been replaced by larger, vigorous plants from Maryland. All of the plants were said to have been protected over the winter and apparently appeared in good shape in the early spring, but later these Maryland plants acted as described above. On certain of the leaves were found rather commonly spores of a Macrophoma said by some also to cause injury. On the leaves and stems much more prominently, however, were developed the fruiting stages of the fungus described here, a lax growth of pinkish spores on the leaves of the Verticillium type and the pink pustules and spores on the stems of the Volutella type.

Just whether the winter protective treatment in a fairly warm winter, the transfer of the plants from a southern climate to a more northern one, or the presence of these unusual parasites on these new plants or all three of these factors had to do with the trouble is still not clear to the writer. Certainly this Volutella (or Verticillium when on the leaves) fungus needs further study in this state, and probably elsewhere, to determine its real parasitic character. We have never run across a *Nectria* (*Nectriella*) *rousseliana* on *Buxus sempervirens*, said to be associated with this fungus as its asco stage.

Leaf blight, *Macrophoma Candollei.* This fungus, mentioned in the preceding paragraph as having also been found on box, is claimed by some as a parasite of the leaves. We are not sure whether it is a true parasite or merely a weak one following other injury. In this case it was on the green leaves that were attached to the dying branches. We have seen it also on the yellowed and dead leaves when we were not sure what was causing their death. It shows in its fruiting stage as small, black pustules with a white mouth, on either side of the leaves, and produces elongated, white, apparently single-celled spores of considerable size distinct from the ordinary Sphaeropsis.

Sun scorch. From nurseries we occasionally receive specimens that show in summer time injured or dead leaves, usually white in color, or even whole branches, with no definite parasitic fungus present to account for the injury. We usually attribute such injuries to sun scorch if the weather has been favorable for such a trouble.

Winter injuries. Severe or even variable winters not so cold may injure box hedges much as just mentioned, when they are not protected by snow or artificial covering. We have seen cases where the injury was limited to the upper, unprotected parts of the plants when the protection was given to only the lower parts. Death may result directly or the injured plants may lag along during the growing season and attract attention as a possible fungous injury.

Broccoli

Black leaf spot, *Alternaria Brassicae.* *See* Cabbage.

Black leg, *Phoma lingam.* Both the leaves and the stem of *Brassica oleracea botrytis* are infected but the injury is started in the latter often from the infected seed. The plants while young are injured with a foot rot, known as black leg, in which the tissues turn black and finally rot away leaving only the interior hard parts. The plant above slowly turns yellow and dies or fails to mature the head. On the leaves the occasional, at first yellow and then grayer, spots grow to about half an inch in diameter, but can be distinguished from other leaf spots on the same hosts by the small, black, embedded fruiting bodies.

Watch the seed bed to avoid using infected plants and if necessary change it. If desirable treat the seed. Rotate the fields to other distinct crops and keep the infected refuse out of the manure pile. Cabbage is also infected in this state occasionally.

Clubroot, *Plasmodiophora Brassicae.* The characteristic feature of this trouble is the greatly enlarged, white swellings on the roots in a variety of cultivated plants and weeds of the Mustard family. In time the infected roots rot and disappear through bacterial invasion. Where bad the plants turn yellow and often die prematurely or fail to properly develop the edible parts for which they are grown. Clubroot here is especially bad at times not only on Broccoli but also on Brussels sprouts, cabbage, cauliflower, kohlrabi, mustard, radish, rutabaga and turnip.

The grower should start with plants free from the disease and practice rotation with other dissimilar crops. If the field becomes badly infected and a further crop is still desired, treat it in the fall with about two tons of lime to render it less acid. However, the farmer, if the soil becomes alkaline, needs to keep potatoes and beets off the land for sometime afterwards. Watch the seed beds that the trouble does not start there.

Downy mildew, *Peronospora parasitica.* *See* Turnip.

Brussels Sprouts

Clubroot, *Plasmodiophora Brassicae.* So far this is the only disease noticed in the state although elsewhere other diseases have been reported. *See* Broccoli.

Bryophyllum

Crown gall, *Bacterium tumefaciens.* While we have never found this gall in nature on this host, Dr. McCormick has easily produced it artificially in our greenhouse by inoculations with germs grown in test-tube cultures. *See* Rose.

Buckwheat

Leaf spot, *Ramularia rufomaculans.* This host, *Fagopyrum esculentum,* apparently has few fungous troubles here. So far the only two seen are leaf spots of which this is the most common but still causes little injury. It shows chiefly on the under side of the leaves as a white, mealy growth in more or less numerous spots.

Poor growth. The chief trouble of buckwheat, as we have seen it in scattered fields over the state, is poor growth apparently due in some cases to insufficient fertilization. In hot dry seasons, however, this may be due to lack of sufficient moisture, the plants becoming prematurely dwarfed and yellowed.

Bugloss (Italian)

Undetermined spot. The only trouble we have found on this plant *Anchusa italica* (vars. Opal and Dropmore) was seen in nurseries at Bristol and Centerville in late October. The leaves, besides being killed more or less at the margins and tips, showed definite, large, reddish-brown spots in the interior of the normal green tissues. The death of the sides and tips suggest frost or scorch injury. No fruiting

stage of a fungus was found though the injury looked like a trouble of that kind. Study of further specimens is desired.

Bush Clover (Pea Shrub)

Fasciation. The only trouble we have recorded on this plant, *Lespedeza formosa (L. Sieboldi)*, was described in Bull. 222: 453. The flattened stems of the two specimens seen were about one to two and a half inches wide. One specimen had two recurved, very similar tips but the other had a smaller, flattened, side-stem further down but each with a recurved tip. Both specimens were provided with numerous small, normal branches from the flattened stems and with immature, aggregated blossoms at the curved tips

Butterflybush

False mosaic. This mosaic-like mottling of the leaves of a species of Buddleia was called to our attention as occurring on plants in Bridgeport early in May, 1932. It was evidently due to a late frost since the later leaves showed no further trouble. *See* Japanese knotweed.

Butternut

Anthracnose, *Marssonia Juglandis. See* Walnut.

Canker, *Melanconium oblongum.* This trouble has been reported by Graves as a weak parasite injuring the trees of *Juglans cinerea* here by developing cankers that eventually cause the death of the infected branches. It has been found in the woods on this slowly disappearing tree. Its mature stage is said to belong to the Ascomycete, Melanconis.

Heartwood rot, *Fomes igniarius.* This has been found here once on a living roadside tree in Hartland. *See* Oak.

White mold, *Microstroma Juglandis.* Occasionally this is seen on the leaves as a continuous, short, white growth on the under side of the leaves of forest trees. It has also been reported once on a cultivated foreign variety of walnut. On the Hickory it is also said to cause a witch's broom effect on the young branches. Apparently the mycelium invades the young stems to produce this abnormal condition. The fungus is considered as one of the low parasitic forms of the toadstool groups known as Basidiomycetes.

Cabbage

Bacterial black rot, *Bacterium campestre. See* Rutabaga. (Fig. 25.)

Bacterial leaf spot, *Bacterium maculicolum. See* Cauliflower.

Bacterial soft rot, *Bacillus carotovorus. See* Iris.

Black leaf spot, *Alternaria Brassicae.* The spots on the leaves of *Brassica oleracea capitata* caused by this fungus are much like those formed by the black leg disease when it occurs on the leaves. However, they can be distinguished from the latter by the fungus developing, instead of embedded fruiting pustules, a more or less evident growth of erect fruiting threads that have a blackened appearance. The spots also usually show concentric rings of development. The trouble is never serious and occurs chiefly on the lower older leaves. It has also been found on several of the related host plants mentioned here, as follows: broccoli, cauliflower, Chinese cabbage, horseradish, radish and rutabaga. This imperfect fungus causing the disease is distinguished from a saprophytic Alternaria, also occurring on the languishing leaves, by the long slender pedicels of its narrow spores which we have previously distinguished as var. *macrospora.*

Black leg, *Phoma lingam. See* Broccoli.

Clubroot, *Plasmodiophora Brassicae. See* Broccoli. (Fig. 26.)

Downy mildew, *Peronospora parasitica. See* Turnip.

Drop rot, *Sclerotinia sclerotiorum.* This is occasionally seen in heads of stored cabbage. *See* Lettuce.

Gray mold, *Botrytis cinerea.* This also develops sometimes in heads under poor storage conditions. *See* Geranium.

Seedling rots, *Pythium debaryanum, Rhizoctonia Solani.* Both of these fungi have been found killing seedlings in the seed beds as described elsewhere for a variety of other seedlings. For treatment *see* Spinach.

Growth cracks. With variable weather conditions as to moisture and heat, the cabbage heads may crack open more or less and cause damage if this extends too far inward. *See* Snapdragon.

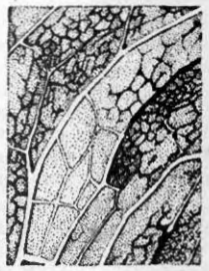


FIGURE 25. Cabbage black rot.

FIGURE 26. Cabbage clubroot.

FIGURE 27. Celery late blight.

Lightning injury. We have seen a case where injury to the plants was largely confined to the edges of the leaves, apparently attracted by their wet condition when the lightning occurred. Ordinarily the injury is much more severe, the plants being killed in a circular space.

Oedema. On seedling and mature cabbages we have seen these intumescences looking like insect punctures. The greenish, swollen, small punctures eventually turn brownish and die, resembling somewhat the corky growth of lenticels. *See* Glorybush.

Prematuring. In variable seasons, we have seen fairly young plants start to blossom the first year and occasionally considerable damage is caused to the expected crop. *See* Lettuce.

Storage injury. In the early winter of 1933, we saw a case of injury to cabbages sold from a New Haven grocery store where the heads, stripped of green leaves, showed the blanched leaves free from trouble. However, on cutting open the cabbages beyond the normal outside layers the inner ones showed a grayish-white, water-soaked appearance with greyish to black areas in the same. A microscopic examination of these tissues failed to show the presence of any mycelium of a fungus or of bacteria. We came to the conclusion that the heads had been injured by unusual cold conditions during storage since there was no injury to the base of the stem above where it was cut off. These cabbages came from outside the state by railroad and either the natural or cold storage conditions had been too severe and so had injured the inner, younger and more moist tissues without harm to the outer, dryer and more mature layers.

Calendula

Mosaic. While not common we have seen mosaic on *Calendula officinalis* and certain other ornamental, herbaceous plants. It shows the rather typical lighter and darker green mottling patterns on the leaves. *See* Cucumber.

Yellows. This is also rather unusual here on this host. *See* Aster.

Calla Lily

Bacterial **soft rot,** *Bacillus carotovorus.* While this trouble of *Richardia africana* has been described as caused by *B. Aroideae,* we doubt if that organism

is distinct from the common soft rot organism occurring in soil rich in organic nitrogen and causing decay in various herbaceous plants. On this host it has been seen only occasionally in greenhouses but one complaint was of rather serious injury.

Care should be taken in the use of organic matter, especially if not well rotted, and in watering the plants. Destruction of the infected tissues of the host should also help. Do not crowd the plants and look to proper ventilation when needed.

Canna

Bacterial bud rot, *Bacterium Cannae.* This is the only trouble we have found on *Canna indica* so far. It has been seen several times in the same city park, becoming most prominent in the wet seasons. The trouble seems to start, after the plants attain some size, in the stem bearing the upper leaves and blossom buds, injuring or killing them. The leaves when infected at a more advanced stage show dead, blackish areas when dry, or when wet they may have a semi-pellucid appearance. Evidently the remedy here is to get rootstocks free from this disease, plant them in new soil and be careful not to overwater the plants.

Carnation

Black leaf spot, *Alternaria Dianthi.* This is one of the worst of the several leaf spots of this plant, *Dianthus caryophyllus.* The spots are whitish with the fruiting stage as a more or less conspicuous, black growth on both the leaves and stems. Some varieties are more subject to it than others and often it becomes established in plants that were grown outside for a time in wet weather. Occasionally the whole plant is killed but usually the injury is confined to the top from a girdled spot in the stem below, or the injury may be confined to the defoliation of the leaves or injury to their tips. *See* Pansy for treatment.

Gray mold, *Botrytis cinerea.* *See* Geranium.

Leaf spot, *Heterosporium echinulatum.* This is similar to but less common than the first carnation disease mentioned here. The spots are perhaps more definite and often have a purplish border. Like the other, it is an imperfect fungus but the spores of the two, borne on the exposed fruiting threads, are readily distinguished under the microscope.

Leaf spot, *Septoria Dianthi.* While this is similar to the last, it can be distinguished by the minute, embedded, fruiting pustules. The treatment is the same for all three leaf spots.

Root rot, *Rhizoctonia Solani.* We have rarely found the fungus rotting the roots of this plant. *See* Potato.

Rust, *Uromyces caryophyllinus.* Rust is the common trouble in our greenhouses on this host, especially on certain varieties. The reddish-brown, semi-dusty spores break out as small, oval pustules or sori, usually partly covered by the epidermis, and are somewhat clustered or more frequently scattered over the leaves and stems. The II and III stages look much alike to the naked eye. The I stage, occurring on Euphorbia, has not been found in this country.

The grower should start with plants free from the rust and try to keep it out by selecting only free stock. If in spite of this it does appear, at the very start he should pick off the infected leaves and spray with Bordeaux, with potassium oleate as a sticker, to keep the plants continuously coated until the danger is past. If the trouble gets a good start, spraying will probably be of little value.

Stem rot, *Fusarium* sp. This trouble is found occasionally on this host, chiefly in the greenhouse. *See* Aster.

White tip. This trouble shows as white spots usually at the tip of the leaves, or in the calyx of the blossoms, where drops of water were present when treated with some insecticide or fungicide. It results from fumigation, or spraying in some cases, usually with some form of tobacco as an insecticide or, less likely, sulphur for mildew. Watch these treatments carefully and fumigate only when the plants are dried of adhering moisture.

Carrot

Bacterial soft rot, *Bacillus carotovorus.* *See* Iris.

Blight, early, *Cercospora Apii* var. *Carotae.* We have seen this on *Daucus Carota* once recently. It was sent from a garden in the northwestern part of the state where it was associated with the leaf blight mentioned below. It apparently is less serious than the latter, but makes a more definite spot. *See* Celery.

Drop rot, *Sclerotinia sclerotiorum.* *See* Lettuce.

Leaf blight, *Macrosporium Carotae.* During the last ten years, especially in wet seasons, we have had some complaint of this trouble by growers. We have also seen several cases in gardens where some damage occurred. The finely divided leaves, or their infected segments, dry up and the black spores of the fungus show on the same. When bad, especially in wet years, all of the leaves of the plant may be killed or become badly injured and the root crop diminished as a result. Recently we have seen what seems to be this same trouble on parsley.

While spraying with Bordeaux will control the trouble, it does not seem to be a very practical remedy especially when the injury is so infrequent in its severity. Rotation, less close crowding and planting on higher, better drained land should ordinarily limit the injury.

Nematode rootknot, *Heterodera radicicola.* *See* Cucumber.

Catalpa

Leaf spot, *Macrosporium Catalpae.* The fungus said to cause this disease needs to be investigated more thoroughly. The Macrosporium, really an Alternaria, that appears on the spots is not very abundant and frequently is absent in the spore stage. The spots are round, reddish-brown, conspicuous and injurious when abundant on the leaves. They are often found on trees in the nurseries and occasionally on shade trees around dwellings. This spot has been found here on *Catalpa bignonioides, C. Kaempferi* and *C. speciosa.* Insects sometimes produce somewhat similar spots but show indications of their presence as injury between the epidermal layers.

Although we have no records of treatments by spraying, we believe that if Bordeaux is applied early in the season, it might control the trouble.

Powdery mildew, *Microsphaera elevata.* This is considered by some as a variety of *M. Alni.* The white coating of mycelium and conidia on the leaves is not very heavy and gives a gray appearance. The rather few perithecia embedded in the same differ in the length of their appendices (that hold them fast to the mycelium) from those of *M. Alni.*

Rarely it merits spraying for control except in nurseries where it might sometimes be done to advantage.

Cauliflower

Bacterial black rot, *Bacterium campestre.* *See* Rutabaga.

Bacterial leaf spot, *Bacterium maculicolum.* This is a trouble that has been noticed here particularly since cauliflower, *Brassica oleracea botrytis,* has been more commonly cultivated in larger quantities. It was first found in the state, before it was described elsewhere, as a new disease on turnip and kale and later on cauliflower, where it seems to cause the most damage, and on cabbage. The bacteria produce small, blackish specks or spots in the leaves, and, if abundant, these run together and yellow the leaves. It is usually troublesome only in wet years. Rotate and try seed treatment if necessary.

Bacterial soft rot, *Bacillus carotovorus.* *See* Iris.

Black leaf spot, *Alternaria Brassicae.* *See* Cabbage.

Clubroot, *Plasmodiophora Brassicae.* *See* Broccoli

Cedar

Nursery blight, *Phomopsis juniperovora.* While apparently we have found this fungus present on the mature trees, it is only in the nurseries on young plants,

especially on the variety of red cedar called *Cannarti* and on *Juniperus scopulorum*, that it has proved serious here to our knowledge. The leaves and stems turn a light brown color and die and the embedded, black, fruiting pustules can be found more or less abundantly in them. No other stage is known.

While certain spraying tests have not, apparently, proved very satisfactory, we believe, if the trouble is taken in its early stage, repeated treatments with Bordeaux will control it in most seasons.

Rust, Bird's nest, *Gymnosporangium Nidus-avis.* As its name suggests this perennial rust, found so far only on our wild cedars in the parks and woods, causes a bunching of the smaller branches into a sort of nest-like affair. On the main trunk and the larger branches, however, we have seen it without this effect, the yellow, gelatinous sori issuing from the cracks in the wood without evident swelling or distortion of the same. This rust was originally described from this state by the Station's first botanist, Dr. Thaxter. It has its I stage on the wild Amelanchier and is said also to infect the quince. The host in Connecticut for this and the succeeding rusts is *Juniperus virginiana.*

Rust (Cedar-Apple), *Gymnosporangium Juniperi-virginianae.* This is the rust that acts as the III stage for the common apple rust, *q. v.* As with other cedar and juniper rusts, this stage develops in the wet weather of April to late June jelly-like horns containing the spores that carry infection to the alternate hosts and later produce the I stage. There is no II stage for any of these rusts here. With this particular rust, the jelly-like horns issue from round galls on the branches that were formed the previous season from infections on the leaves from the apple-rust spores. In these horns are produced the III spores which germinate in position and bear smaller, temporary spores that are carried by the wind to the apple leaves and produce there the apple-rust stage.

Here in Connecticut the owners of ornamental cedars are often as much interested in them as in the apples, so common destruction of cedars to prevent apple rust is not generally advocated. However, cedars should not be planted near apple orchards or the cultivated very susceptible Betchel's Flowering Crab. Destruction of the galls before fruiting might be helpful to both hosts. Spraying the cedars in July just before the apple-rust spores are produced and repeating before or after rains until the end of the season probably would require too many treatments to be profitable.

Rust (Cedar-Hawthorn), *Gymnosporangium globosum.* This is very similar to the cedar-apple rust in that it produces small, round galls on the red cedar known as "cedar apples". The galls in this case are said to be perennial, producing the jelly-like horns containing the III spores each year in the spring. The horns are tongue-shaped, shorter and flatter than those of the more common cedar-apple rust. Its I stage develops commonly on the hawthorn, *q. v.*, or occasionally on one or two related hosts.

Rust (Cedar-Quince), *Gymnosporangium germinale.* This fourth rust develops its small, jelly-like III stage in the wood of slightly swollen branches of both the cedar and juniper. The I stage occurs on the fruit and bark of certain pomaceous hosts like the quince, hawthorn, shadbush and apple.

Celery

Bacterial soft rot, *Bacillus carotovorus.* *See* Iris.

Blight, early, *Cercospora Apii.* This leaf trouble of *Apium graveolens* appears in the celery fields usually in August, becoming evident then or later, and is called the early blight, as it precedes the disease next discussed. The light to reddish-brown spots are larger and more irregular than the late blight and the fruiting stage usually shows as short, grayish threads bearing the spores. This same species is found here on celeriac, while on carrot and parsnip distinct varieties have been named. The injury is usually less severe than that caused by the late blight but both are controlled by the same treatment.

Blight, late, *Septoria Apii.* Late blight appears soon after the early blight gets a fair start and the two are often seen on the same leaves. The late blight has smaller, more numerous spots and produces embedded, black, fruiting pustules, called pycnia, from which the spores ooze out following wet weather and spread the disease. Both diseases are caused by imperfect fungi of which the asco stages are unknown. The late blight is commonly the more injurious, especially on the petioles, and is a source of subsequent injury to the plants stored under conditions favorable for its later development and for that caused by other fungi. (Fig. 27.)

Some investigators advocate dusting as giving good results. In this state, however, we prefer thorough spraying with Bordeaux, beginning in July as soon as the celery starts to grow in the field and repeating every 10–14 days, according to the weather, until the last of October if necessary. Whether a grower needs to spray depends on the location of his field, the variety grown (self-blanching varieties are often more susceptible) and his previous experience of injury from these troubles. At any rate it is best for him to start with plants that are free from the diseases and were sprayed in the seed bed as a precautionary measure.

Gray mold, *Botrytis cinerea.* This is rarely seen in storage. *See* Geranium.

Rots, *Pythium debaryanum, Rhizoctonia Solani.* These two fungi have been seen both on seedlings and also as causing injury to more mature plants. *See* Potato and Spinach.

Brown root rot. This trouble has been seen several times in which the bunched, shortened, reddish-brown roots failed to develop properly and so hindered the proper growth of the tops. It looked like a soil-fertilizer trouble of some kind, similar to that of tobacco and onions mentioned here.

Crinkle. Occasionally we have found a trouble of this sort where the leaves were puckered and sometimes slightly mottled. It does not appear to be a true mosaic type of injury but rather one due to a variable season for growth, perhaps when a dry, slow growing period is followed by a wet one causing sudden, vigorous growth.

Celeriac

Blight, early, *Cercospora Apii.* As this plant, *Apium graveolens rapaceum*, is not so commonly grown here as formerly neither this nor the next fungus is so commonly found on it as on Celery, *q. v.*

Blight, late, *Septoria Apii.* *See* Celery.

Chard

Leaf spot, *Cercospora beticola.* This is the common leaf spot of beet, chard *(Beta vulgaris cicle)*, mangel and ornamental beets, on all of which it has been found here. The spots are round, light colored, with a definite, purplish and often slightly raised border and are frequently abundant on the leaves. The fruiting stage is more or less evident according to season and weather conditions and consists of short, erect, tinted threads bearing the more conspicuous, lighter-colored spores. It is an imperfect fungus whose asco stage apparently is not yet known.

It is sometimes quite bad in sugar-beet fields but in Connecticut it rarely merits special preventive treatment other than care in selection of good seed and rotation. If necessary it can be controlled by proper spraying.

Cherry

Anthracnose, *Cylindrosporium Padi* (called by some *C. hiemalis*). The disease is sometimes very bad on cherry, when the early season is moist, so that considerable defoliation results. It occurs on both *Prunus avium* (sweet) and *P. Cerasus* (sour) but is worse on the latter. While it occurs on other related species it seems to be bad chiefly on the wild black and choke cherries. The fungus is called by some *C. lutescens* on these other hosts. It produces numerous, small purplish spots on the leaves on the under side of which the ooze of the spores may show as a yellow-pinkish globule. On some hosts shot-hole in the leaves may result. The asco stage occurs on the old leaves in the spring and is known as *Coccomyces hiemalis.* It seems probable also that the conidial stage may be carried over on the young twigs of some of the hosts.

Spraying should be started before the middle of May on the young immature leaves and repeated several times until the leaves are fully grown in July. *See* also Plum, where it is sometimes called *C. prunophorae.*

Black knot, *Plowrightia morbosa.* This has been found most commonly on the sour cherry. *See* Plum. (Fig. 28.)

Brown rot, *Monilia cinerea. See* Addenda for detailed treatment of this trouble.

Leaf curl, (Witch's broom), *Exoascus Cerasi.* This witch's broom species is occasionally found here perennial in the branches of the cherry. One or more of the branches prematurely develop the leaves so that when the rest of the tree is in full bloom their green leaves stand out in evident contrast to the white blossoms. For treatment *see* Peach.

Powdery mildew, *Podosphaera Oxyacanthae.* This is only occasionally troublesome, producing the most injury to seedlings in the nursery or on the tips of the twigs of the older trees. On the younger tissues it forms a felt of the white mycelium which becomes less evident on the surfaces of the mature leaves. In time the small, reddish-black perithecia of the asco stage appear embedded in or on this mycelial and conidial growth. Besides being found on cultivated cherries and plums, this mildew has been collected here on wild species of *Prunus serotina* and *P. virginiana.*

Spraying should begin on the opening buds with Bordeaux or some less injurious spray, as dry mix, and continue as needed for three or four treatments.

Winter injury. This usually shows on the older trees by the sudden or gradual death of the larger branches, in the latter case the leaves turning yellow and dying prematurely with no evident cause of the trouble. These dead and weakened branches should be cut off and in the spring a fertilizer be given to stimulate new vigor to both roots and branches.

Chestnut

Blight, *Endothia parasitica.* Since this trouble was first noticed in this state about twenty-five years ago, it has carried off all of the old trees and most of the sprouts and seedlings of younger growth. Today because of the scarcity of the host, *Castanea dentata*, the fungus is not nearly as abundant and so the chance of infection of the remaining sprouts and seedlings is lessened. The fungus is a typical Ascomycete, producing cankers killing the bark and cambium. When the girdling is completed, the parts of the host above are killed, with the dead leaves often adhering for some time. The conidial stage shows as yellowish, sticky exudations of spores produced from internal fruiting chambers and is followed by the asco stage in the same reddish, grouped tubercules in which are embedded the minute, black necks for the discharge of the ascospores.

In the late fall of 1932, we saw at Lebanon what apparently was the last living old tree in our forests. Although it was badly diseased, efforts were made to keep it alive. We have seen several moderately large trees of the Japanese chestnut, *Castanea crenata*, that have remained nearly free from the disease. Certain other Asiatic species are said to be fairly immune.

Those who have wood lots where the chestnut still survives should annually go over the woods and cut out and burn all of the infected sprouts, thus lessening further spread to the sprouts still free. The Station has started five small plantings of seedlings in the state from nuts grown in the south, in the hope that these and the natural seedlings here may eventually escape the destroyer and help bring back this valuable tree in our forests. We are basing our hope on the less favorable conditions for the spread of this disease, together with the possibility that the fungus may gradually lose its virulence as a parasite.

Leaf spot, *Marssonia ochroleuca.* Once fairly common, the leaf spot, caused by this imperfect fungus whose asco stage is unknown, is now rarely seen. It forms small, round, light-brown spots with a reddish border and in the center are the inconspicuous, embedded, fruiting pustules.

Powdery mildew, *Microsphaera Alni.* This fungus coats the leaves in late summer and fall and is not uncommon on the sprouts and seedlings. *See* Lilac.

Wood rots, *Polyporus Spraguei. P. sulphureus.* While a large number of species of the Basidiomycete have been found on the bark and wood of dead chestnuts and while the heartwood of the living trees is sometimes rotted, we have not generally found their fruiting bodies on living trees to identify the cause of their decay. The fungi listed above are two that have been seen and commonly ascribed to heartwood rots.

Fasciation. We have one specimen from Ansonia, collected in May, 1910, of a young sprout showing a moderately flattened stem with a smaller, flattened side branch but the main one with a further bifurcation ending in slightly flattened and curved tips. *See* Asparagus.

Chinese Cabbage

Bacterial soft rot, *Bacillus carotovorus.* The rot has been found rarely in wet seasons when this infrequent plant, *Brassica pekinensis*, is grown. *See* Iris.

Black leaf spot, *Alternaria Brassicae.* It was found first at the Station's Mount Carmel farm. *See* Cabbage.

Clubroot, *Plasmodiophora Brassicae.* So far this has been seen only on inoculated experimental plants. *See* Broccoli for description and Turnip (White) for further statements.

Leaf spot, *Cercosporella albomaculans.* This unusual fungus forms a more or less evident growth of short, dark threads bearing white spores on small, grayish spots in the infected leaves. It has not yet been connected with a perfect stage. The white turnip is another of its hosts in the State. Because it rarely becomes of economic importance, no attempts for control have been made.

Chinese Lantern

Leaf spot, *Phyllosticta Physaleos.* On *Physalis Francheti*, now being grown occasionally in our gardens, this leaf spot has been seen once. It shows as circular, gray to brown spots with a darker border and bears the embedded, black, imperfect fruiting stage of the fungus usually in the center. Apparently the fungus has never been reported on this particular host and little is known concerning it.

White smut, *Entyloma australe.* This also was found here only once. *See* Groundcherry.

Chives

Rust, *Puccinia Porri.* This rust occurs on *Allium Schoenoprasum* in all three stages, though so far we have not seen the I stage and the II has been found more often than the III stage. It has been collected here not only on chives but also on the Egyptian perennial onion. The sori appear as little blisters that open with a central slit in the epidermis which, wearing away, discloses the reddish-brown spores. The thicker epidermis of the onion allows it to protect the spores for a longer time than on the chives where also the outbreaks often appear more numerous, probably due to the more ready dispersal of the II spores.

Once the rust gets a start on these perennial plants, it is apt to appear year after year and in favorable seasons it causes considerable damage. The grower, if the trouble appears, should again start with plants free from the rust and plant in a new place.

Chrysanthemum

Crown gall, *Bacterium tumefaciens.* This trouble has recently been collected on roots of greenhouse chrysanthemums where it was quite conspicuous. *See* Rose.

Leaf spot, *Cylindrosporium Chrysanthemi.* We have found both a Cylindrosporium and a Septoria on this host and there is some question whether or not they are really distinct, though the latter forms a definite pycnium or fruiting body enclosing the spores in the leaves while the former merely oozes out its similar spores without a very definite enclosing layer of sterile threads. Both

produce conspicuous, blackish spots or areas in the leaves and cause them to turn yellow and drop off, defoliation taking place from the base of the stem upward. When very severe this prevents cutting stems long enough to have proper foliage for the blossoms even if the latter are in prime condition, which very often they are not due to improper nutrition from this lack of foliage.

The grower should watch the young plants for this trouble, avoid excessive use of water, especially on the leaves, and use care in ventilation to dry off excessive moisture. If the trouble appears and it is necessary to prevent spread, spray before the blossoming period with Bordeaux. Potassium oleate used as a spreader certainly will stick the Bordeaux so that it will not easily wash off.

FIGURE 28. Cherry black knot.

FIGURE 29. Chrysanthemum rust.

FIGURE 30. Corn smut.

Powdery mildew, *Erysiphe cichoraceanum.* So far only the conidial stage has been found on this host. *See* Rose.

Rot of Cuttings, *Rhizoctonia Solani, Botrytis cinerea.* We have found both of these fungi rotting the cuttings of certain susceptible varieties, like Bonnaffon, when starting the roots in sand. The former acts as a soil parasite, the mycelium spreading in the sand and rotting all the cuttings in the area, and the latter develops spores on the languishing leaves and through them spreads the disease to the stems.

Sterilization of the sand, use of hardened rather than tender growth for cuttings, care in the use of heat and water, spraying the cuttings and soil with potassium sulphide (1 oz. to 10 qts. water), may all be essential to success with the very susceptible varieties.

Rust, ***Puccinia Chrysanthemi.*** The rust shows as rather conspicuous, round, dusty, reddish-brown pustules either grouped or scattered, usually on the lower side of the leaves. Only the II stage has been found here. **(Fig. 29.)**

The grower should watch to keep the rust out of the greenhouse by using only healthy cuttings and plants. He must avoid the most susceptible varieties, pick off the first leaves if rust appears and start spraying to prevent further spread.

Leaf drop. This trouble sometimes appears in greenhouses on certain varieties where the leaves become black-spotted or merely turn yellow and drop off, very much like the leaf spot disease but with no sign of infection by that or any other fungus. Sometimes too close planting may have something to do with root competition but to the writer it seems to be due to unfavorable soil condition (due to unbalanced fertilizing elements) the exact nature of which has not yet been disclosed.

Clematis

Leaf spot, *Cylindrosporium Clematidis.* This usually shows as small, numerous, angular spots on the leaves with the imperfect fruiting spores (asco stage unknown) oozing out sometimes in a whitish exudation. It is found chiefly on the wild species, *Clematis virginiana*, or on the same in cultivation. Investigators, so far, seem to have disregarded it in control treatments.

Rust, *Aecidium Clematidis.* The I stage of this rust occurs on the leaves, especially of wild species, in rather small, closely clustered, white cups. The II and III stages go under the same specific name as a Puccinia and occur on certain grasses, being especially common on quack grass. The infection of the cultivated Clematis depends on its species and the proximity of the infected grasses and so is not common.

Clover

Black mold, *Macrosporium sarcinaeforme.* This leaf trouble shows as reddish-brown spots usually with indications of concentric rings of growth. It can easily be told from other clover fungi by the microscopic appearance of its spores which are borne on the short exposed threads on the surface of the leaves. It is, as yet, not connected with an Ascomycete as a mature stage. It occurs here on red clover, *Trifolium pratense,* causing moderate damage at most. Since clovers are very rarely grown in pure stands in Connecticut, the damage resulting from the different diseases are not sufficient to merit control. *See* Alfalfa.

Leaf spot, *Pseudopeziza Trifolii.* Like the similar fungus on alfalfa, this trouble shows as reddish-brown spots on the leaves where at the center can usually be seen the small, saucer-shaped, fruiting-cup of the Ascomycete causing it. Apparently it is less common than the preceding disease and so far has been found here only on the red clover.

Powdery mildew, *Erysiphe Polygoni.* A few years ago this mildew became prominent on the leaves of red clover over Eastern United States. It seems never to occur except in its conidial stage and varies in prominence according to the weather of each year though always present somewhat. It has rarely been found here on alsike, *T. hybridum,* and never on white clover, *T. repens.* Besides the clovers, this mildew has a wide distribution of hosts mostly of the Pulse family. However, in many of these hosts it is limited to its conidial stage and this and its late appearance usually diminishes the damage it causes, so little is done to control it. Like all powdery mildews, it is largely an external parasite and so subject to rather direct control by spraying and dusting. The other hosts listed here are: cowpeas, larkspur, Lima and string beans, lupine, peas (garden and sweet), rutabaga and turnip.

Rusts, *Uromyces hybridi, U. Trifolii, U. Trifolii repentis.* Formerly considered as one species of rust on all clovers, botanists now distinguish the preceding rusts as limited, in the order named, to alsike, red and white clovers. These rusts are all autoecious, that is, have the I, II, III stages on the same host. The cluster cup stages, however, are rarely seen and then only in the spring and are missing so far here with the red clover rust which is the most common of the three.

Sooty spot, *Polythrincium Trifolii.* The fungus in this stage shows as small, black, fruiting threads on the leaves and later as more permanent, black pustules in its asco stage, known as *Phyllachora Trifolii.* It is common here on the white and alsike clovers and less so on the red and crimson clovers.

Mosaic. This disease is occasionally seen on single plants, or a few adjacent ones, and evidently is carried by lice and becomes perennial. *See* Cucumber.

Columbine

Gray mold, *Botrytis streptothrix.* Recently Dr. McCormick obtained a Botrytis from the rotting tissues of a cultivated species of Aquilegia. So far as we have found, no species of this genus has been reported on this host. Artificial cultures gave a scanty mycelial and spore growth of the Botrytis and numerous, small, black sclerotia very similar to those obtained from the Tulip, *q. v.,* rather than to the more luxuriant mycelial growth we have obtained from the Peony, a more nearly related host, though it differed from both in the nodulose conidiophores.

Powdery mildew, *Erysiphe Polygoni.* The only other diseases found on species of Columbine is the powdery mildew, seen only in its conidial stage, and an undetermined leaf spot. For powdery mildew, *see* Clover.

Corn

Anthracnose, *Colletotrichum graminicolum.* One of the minor leaf diseases of *Zea Mays* is this one, since it causes small damage and is infrequent in occurrence. It starts as small, brownish, oval spots that may run together into elongated areas lengthwise of the leaf bearing the embedded fruiting pustules with exposed, black spines. It has been found here so far on sweet corn and on [illegible]ghum. On the latter the disease causes a reddish color. Control measures are unnecessary.

Bacterial leaf spot, *Bacterium Holci.* As early as in 1916 at a seed farm in Orange we found a bacterial leaf spot disease on sweet corn, and in 1921 in Hamden, and again in 1928 at a different farm there, and also in Hazardville. Although not determined until recently, all four specimens seem to agree best with the description and specimens of the above disease on corn which has also been reported elsewhere on several other hosts. In no case did we find it a very common or serious injury and as most of the injured leaves were on the lower part of the plant and the chief injury was on their outer halves that could reach down to the ground, we believed that the trouble came originally from germs in the soil.

The injury showed usually as small, elliptical to more elongated spots. At first when matured, these were a reddish-brown, especially when water soaked, but when dry they were either reddish-brown or at length a lighter brown in the center with margins darker. When the spots were abundant, they often killed the intervening tissues which also turned a light brown and so more or less obscured the spots in the dried specimens.

Bacterial sheath blight, *Bacterium Andropogoni.* This disease shows especially on the inner, enveloping sheaths of the leaves as a reddish to purplish-brown discoloration, usually involving most of the inner tissues in a wet to dry rot according to the moisture present. I think that Burrill included it under his *Bacillus Zeae* which he also associated with other injuries of corn in various stages of its growth. At least the writer, then associated with him, collected such specimens in Illinois and so named them. We have frequently seen this same sheath injury here in Connecticut but have made no special bacterial study of the same. For further statement *see* Sorghum.

Bacterial (Stewart's) wilt, *Aplanobacter Stewarti.* In 1932 and 1933 this disease proved unusually serious in this state. *See* Addenda for detailed statement.

Ear rots, etc., *Diplodia Zeae, Fusarium moniliforme, Basisporium gallarum, Cladosporium Zeae.* In late, wet or short growing seasons, growers sometimes have trouble with ear rots both in the field and storage. However, they do not [illegible] nearly as much as those who grow corn in the states farther west. The first two of the fungi mentioned here, possibly also the Fusarium stage of the root rot, are the chief causes of ear rot. The Diplodia can be told by its pure-white mycelium, when protected, and the small, black, fruiting bodies of its imperfect stage, so far the only known stage. The Fusarium species are also told by the white, external mycelium, with finally a pinkish coloring especially upon spore formation.

Concerning the third fungus mentioned, we have rarely found it and then on the mature or nearly mature ears of sweet corn where its white mycelium has invaded the cob and the base of the kernels in the chaff, blackening the same by the production of its dark spores produced externally. It seems to be a semi-parasite that invades the injured or improperly matured tissues, especially in seasons poor for their natural maturity.

The so-called *Cladosporium Zeae* is a saprophyte that is occasionally found (Rept. 1906:314) on the cobs of storage corn, showing as a black growth on certain of the immature kernels.

The grower should start with good seed, practice rotation, properly cure his seed and he need fear little trouble, except in very unfavorable seasons, from these fungi.

Leaf blight, *Helminthosporium turcicum.* This trouble shows late in summer or early fall, following moist weather, as a rather sudden scorch of the leaves as if hit by an early frost. The fruiting threads, bearing the dark spores of the imperfect stage, show as a more or less evident, black growth on the injured tissues.

Late planting, preventing proper maturity, and poor fertilization are two contributing causes, so the poor growers are those who suffer the most. The trouble is so uncertain that other precautions are not profitable.

Root rot, *Gibberella Saubinetii.* It is generally believed that this fungus, especially in the Fusarium stage, is largely responsible for the common root rot of corn as it comes to semi-maturity in the field. The roots are rotted off and the base of the stalk is invaded. If the main or holding roots are gone, the stalk is often blown over. A reddish discoloration may even show at the internodes above when the stalk is split open. Sometimes the Fusarium stage can be found in the diseased roots or stalks and frequently it shows in the ear as one of the ear rots previously described. The mature or asco stage is also found here but, less evident, on mature parts of the stalk.

The character of the soil as to its chemical constituents and the growing of small grain crops subject to the disease on the same land are factors in its serious development in the west. Here in Connecticut these unfavorable factors are largely lacking, so we do not suffer as much from this trouble. Good seed and rotation help us still further.

Rust, *Puccinia Sorghi.* This rust shows as reddish, dusty outbreaks on the leaves in its II stage; later the III stage develops lead-colored pustules more firmly covered by the epidermis. The I stage occurs on Oxalis, woodsorrel, and ha[illegible] not been found in this state. The rust is fairly general here but sometimes becomes abundant in certain fields or on certain varieties, the reason for which is not evident. Remedial measures apparently have rarely been tried.

Smut, *Ustilago Zeae.* As this is our most common fungus and as it [illegible] parts of the plant, especially the tassels and ears, we consider it as our most serious disease of corn, especially of sweet corn. The fruiting pustules, varying from small on the leaves to large in the ears, are at first covered by a white envelope but when mature show as black, dusty masses and are familiar to every one who has grown corn. This black mass is the chief spore stage but these spores on germination, especially in manure, give rise to temporary, secondary spores that, blown by the wind to any exposed young tissues of the corn, produce local infection there. (Fig. 30.)

Seed treatment is of no use as it is with some other grains. It has been claimed by s[illegible] that if the immature smut balls are carefully gathered and destroyed several times a year, the succeeding crops, if sufficiently isolated and fresh manure avoided, will show less infection.

Alb[illegible] sometimes appears in seedlings, especially when recently crossed. These fail to mature if all of the leaves are white. Occasionally one finds mature plants with some indication of the lack of chlorophyll in certain of the leaves.

Hail injury. *This injury sometimes occurs. See* Onion.

Poor seed. Here our growing season is so short that care has to be taken to grow for seed only varieties that will mature before frost. With wet, cold weather and early fall frosts, as elsewhere, even this precaution sometimes fails. Care, too, has to be given to the proper curing and storing of the seed after harvesting it. Seedmen and growers who save their seed are aware of these difficulties. Yet there occasionally come years when seed is generally poor over the coun[illegible] Then it is especially true that the grower needs to test his seed for germination before planting in order that he may use only the best available.

Cornflower

Crown rot, *Sclerotium Delphinii.* We found this once in 1932 on the base of the cornflower, *Centaurea cyanus,* in a flower garden where this fungus was common and serious on a variety of herbaceous plants. *See* Larkspur.

Rust, *Puc[illegible] Cyani.* This rust is occasionally found on this host, also called Bachelor's Button, producing numerous, circular, dusty, reddish-brown outbreaks occasionally on the stems but chiefly on the leaves especially on the lower sides. These pustules consist of the spores of the II and III stages, the latter being

a little later in appearing and darker in color. Apparently it has no cluster cup stage.

As the host is practically an annual here, the rust need not become troublesome, since one can get seed from a different source and plant it in a new place another year.

Cosmos

Stem canker, *Phomopsis Stewartii.* This trouble shows as evident spots, at first purplish, on the lower nodes of the stems of *Cosmos bipinnatus* causing, when bad, serious decay. The fruiting stage in these spots shows as little, black, embedded bodies bearing the imperfect spores but its asco stage is unknown. Circular, brown spots on the leaves have also been seen by us that may have been caused by this same fungus.

The most satisfactory treatment probably consists in pulling up and destroying the infected plants and spraying the lower parts of the remaining ones to prevent further spread of the trouble.

Cotoneaster

Red canker, *Tubercularia vulgaris.* The only trouble we have seen on these shrubs, *Cotoneaster horizontalis,* has been in a nursery where this imperfect stage of *Nectria cinnabarina* showed as reddish tubercules on the dead bark. The trouble to this host resulted probably from winter injury in the first place rather than from this fungus which at best seems to be a weak parasite following other injuries.

Pruning off the injured branches and protection against winter and drought injuries are the remedial measures suggested.

Cowpea

Bacterial spot, *Bacterium Vignae.* None of the diseases listed on *Vigna sinensis* are so common or important here as to require preventive treatments as yet, so we merely give short descriptive characters to distinguish them. This spot has been found here once, at the Station's Mount Carmel farm, and is the same species that occurs commonly on the Lima bean, *q. v.*, and produces similar spots.

Leaf blight, *Cercospora Dolichi.* This leaf blight is caused by an imperfect fungus whose asco stage is as yet unknown. The fungus causes evident, reddish discolorations that usually assume a circular shape, become about a quarter of an inch in diameter and develop a grayish center. On this the fruiting stage may be seen as a scattered, often inconspicuous, grayish growth of fertile threads and spores.

Leaf spot, *Amerosporium oeconomicum.* This fungus produces spots very similar to the preceding but can be told by its imperfect stage, likewise unconnected as yet with an asco stage, showing as a few, black bodies embedded in these spots.

Powdery mildew, *Erysiphe Polygoni.* So far we have found the conidial stage only. *See* Clover.

Cucumber

Anthracnose, *Colletotrichum lagenarium.* This is occasionally serious, and is found chiefly on the leaves of *Cucumis sativus. See* Watermelon.

Bacterial angular spot, *Bacterium lachrymans.* We have found this bacterium on cucumber, muskmelon and squash but it causes serious damage only to the first host where, if present in wet years, the injury may be considerable. The germs cause small, angular spots on the leaves, rarely here on the cucumber fruit, which are reddish-brown and in wet weather show as thin, water-soaked areas, especially when the infections run together. Sometimes the bacteria ooze out on the surface in tear-like drops, hence the specific name.

As the germs can be carried by the seed, sterilization of the same if suspicious (soak seed 5 minutes in 3½ gallons of water containing ¼ oz. corrosive sublimate) may be given and rotation practiced, especially when there has been trouble with

a previous crop. If the disease appears, spraying with Bordeaux may prove helpful if done in time.

Bacterial soft rot, *Bacillus carotovorus.* This may appear in the fruit in wet weather, often following the preceding trouble, as a general rot. *See* Iris.

Bacterial wilt, *Bacillus tracheiphilus.* Wilt is not uncommon in favorable seasons, wilting and killing the vines. *See* Squash.

Damping-off, *Pythium debaryanum.* This is found occasionally in seedlings. *See* Spinach.

Downy mildew, *Peronoplasmopara cubensis.* In past seasons this was one of our worst diseases appearing on this host before it developed on muskmelons, *q. v.*

Powdery mildew, *Erysiphe cichoraccarum.* Powdery mildew usually appears late in the season, in the conidial stage only, and does not cause much harm. *See* Phlox.

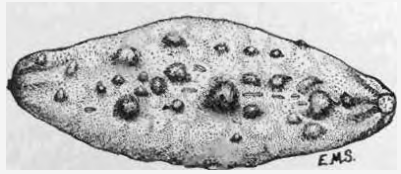


FIGURE 31. Cucumber white pickle.

FIGURE 32. Currant anthracnose.

FIGURE 33. Gooseberry mildew.

Scab, *Cladosporium cucumerinum.* This occurs here on cucumber and muskmelon on the leaves and stem but chiefly on the fruit where the damage is most serious. It shows in the latter as small, sunken areas which under moist conditions are covered with a copious growth of the olive, fruiting threads of the immature stage, so far the only known stage. Sprayed vines do not usually suffer.

Nematode rootknot, *Heterodera radicicola* (*H. Marioni*). We have seen this trouble worse on greenhouse cucumbers than on any of the numerous hosts. Those included here are: aster, begonia, carrot, cyclamen, cucumber, gardenia, ginseng, parsnip, primrose, rose, snapdragon, tobacco, tomato. Others are probably just as susceptible if grown under favorable conditions for infection. The disease is caused by small worms, called eel-worms or nematodes, which infect the young internal tissues of the roots gathering their food from them and reproducing their young from eggs deposited there. These invasions cause the roots to develop fusiform swellings which frequently become large and numerous but in the end quickly decay. Finally the plants suffer from lack of sufficient food and moisture for growth of the parts above the ground.

This species of nematode cannot usually live over winter out of doors, so field crops are not usually bothered here as they are in the south where the land sometimes becomes badly infected. In greenhouses and protected seed beds, however, the soil often becomes so badly infected that it is desirable to prevent further trouble in succeeding crops. In such cases careful removal of the infested soil or subjecting it to complete winter conditions or to its sterilization in place with high pressure steam is the remedial treatment.

Mosaic. This trouble is similar to or the same as the tobacco mosaic. The cause of the yellow-green mottling of the normally green leaves has not been determined but it is a so-called virus disease which is infectious. The *white pickle* (Fig. 31.) of the fruit, due to a similar mottling but one which produces irregularities in growth, is to our mind merely another manifestation of the same trouble. Other cruciferous crops such as squash, pumpkins and muskmelons are similarly infected. Some believe that the trouble can be carried at times in the seed. At one time it was the most serious trouble of cucumbers but it has not been so bad recently. Lice

are the common carriers of the disease from the infected to the healthy plants in most cases.

Care in selection of good seed, rotation, destruction of the mosaic weeds around the fields including their lice, all are necessary to success in seasons that favor mosaic production. *See* Tobacco.

Currant

Anthracnose, *Gloeosporium Ribis.* While both currants and gooseberries are subject to this trouble, the common red and white currants, *Ribes vulgare,* suffer most, especially in the years when it is abundant. The leaves are the chief point of attack and show purplish to reddish-brown spots, usually small in size and numerous, with a pinkish globule of spores oozing out on the under surface when fruiting. When infection is abundant defoliation is severe. The asco stage, as yet not found by us, develops on the old and dead leaves in the spring and is known as *Pseudopeziza Ribis.* (Fig. 32.)

Early spraying with Bordeaux, preferably begun before the leaves start to develop and repeated as needed, is necessary for control in the seasons favorable for the disease.

Bitter rot, *Glocosporium rufomaculans.* This rot has rarely been seen on the fruit. *See* Apple.

Cane blight, *Botryosphaeria Ribis.* The cane-blight fungus has been reported by others as causing trouble here. The canes are killed and the fruiting stage of the Ascomycete causing it shows as small, black, rough cushions on the dead stem. While we have had no complaints, it is said to cause serious trouble elsewhere in currant plantations. It is well, therefore, to destroy by burning any infected canes, or whole bushes if bad, to hinder further spread.

At the same time we have seen similar trouble, due to winter injury, on the weakened and dead branches on which appears another fungus which might tend to confuse these two troubles. In this latter case the fungus (*Nectria cinnabarina,* sometimes called *N. Ribis*) appears as smooth, yellowish tubercules in its conidial stage (with age blackish) and as reddish, roughened ones in its asco stage and develops as a weak parasite or saprophyte following the injury.

Leaf spot, *Septoria Ribis.* This is usually not abundant enough to cause conspicuous damage. *See* Gooseberry.

Powdery mildew, *Sphaerotheca Mors-uvae.* This mildew is infrequent but capable of injury. *See* Gooseberry.

Rust, blister, *Cronartium ribicola.* This rust has its conspicuous, cluster-cup stage on the stems of white pine where it is so destructive. Spores from these are carried long distances to currants and gooseberries and produce infections there in late spring and early summer. These develop small, yellow spots on the leaves on the under side of which appear the II stage as minute, clustered pustules that ooze out the yellowish, dusty spores that spread the disease through the summer. In late summer or early fall in these same spots appear short, reddish, hair-like growths of the III stage. These are composed of united spores that germinate in position immediately in moist weather and develop numerous, smaller spores that blown by the wind carry the disease for short distances and infect the pine needles. *See* Bull. 214.

Of all the hosts, the black currant seems the most susceptible and so its cultivation here is prevented by law. The ordinary red and white currant at times are abundantly attacked, as well as the yellow currant, *R. odoratum,* while cultivated gooseberries seem to be much less injured than some of the wild species. The currants can be sprayed with Bordeaux to lessen this trouble but in most regions of the state this is not necessary. *See* White Pine.

Rust (Cluster cup), *Aecidium Grossulariae.* In this case the I stage of this entirely different rust appears on currants and gooseberries, while the II and III stages, as *Puccinia Grossulariae,* infest wild species of the sedges of the genus Carex. The I stage is evident as more or less numerous, small, white, toothed cups, containing the orange spores, situated generally on the under side of the leaves. Rarely any very evident damage results to the invaded host and so no preventive treatment is necessary.

Chlorosis. This trouble occasionally shows on individual leaves or those of a branch as a yellow-white mottling in the normal green color. Rarely this may be due to insects but usually it seems to be caused by some unfavorable but obscure weather or soil conditions.

Winter injury. Such injury occasionally occurs in severe winters or exposed places; *see* trouble mentioned here under Cane Blight.

Cyclamen

Gray mold, *Botrytis cinerea.* It has been found occasionally on plants kept too wet. *See* Geranium.

Nematode rootknot, *Heterodera radicicola. See* Cucumber.

Leaf spotting. While certain varieties normally develop a purplish color on the under side of the leaves, we have had complaints of a green variety where certain plants become abnormally so spotted beneath. This abnormal appearance hindered their sale and apparently also affected somewhat their general vigor. The cause could not be exactly determined in this case though variable conditions in heat and moisture during their growth may have been responsible. The grower did not think it came from fumigation or spraying with tobacco since all plants were equally exposed.

Daffodil

Bulb injury. Recently we received injured bulbs of Daffodil sent us by a seed house in Hartford which had received them from the Pacific coast. There was a question whether the bulbs had been injured by fumigation, improper storage or other conditions. Dr. McCormick found considerable of the fruiting stage of a Penicillium on the dried coats as the only fungus present but we had no proof that this fungus was primarily responsible for any injury. Some of the bulbs when planted later did fairly well and with no fungous injury, so any injury that occurred seemed to be due to the other unfavorable conditions rather than to a parasite.

Running-out. Aside from the preceding complaint, we often find that these and similar bulbous plants do poorly after establishing themselves in the ground a few years. In such cases, while the foliage may be good, the plants fail to bloom freely or not at all. Transplanting the divided bulbs, when necessary, in new soil with more room often proves helpful but sometimes it is desirable to secure new, vigorous bulbs grown in a different region.

In this connection it may be said that better fertilization, while it may affect the vegetative growth, will not, usually, increase the number of blossoms of that year though it may increase their vigor. This is because the blossom buds of certain bulbs are laid down in them the previous year and their number at that time is decided by the favorable or unfavorable condition for the vigor of these bulbs.

Dahlia

Powdery mildew, *Erysiphe cichoracearum.* The mildew is usually not very abundant and is seen chiefly in its conidial stage, but in late October the asco stage has been found here rarely. *See* Phlox.

Mosaic. Only occasionally is the trouble seen on this host. *See* Cucumber and Tobacco.

We have sometimes seen what we considered yellows of the virus type but have never proven its infectious nature. *See* Aster.

Drought injury. In very dry years after very hot weather, the leaves of this plant frequently turn yellow at the margins and sometimes die inward for a shorter or longer distance. This injury might be mistaken for the true "yellows" which is a more serious, infectious disease. However, with this drought injury there is no danger of recurring injuries from planting the bulbs from the injured plants.

Dandelion

Leaf spot, *Ramularia Taraxaci.* The three diseases mentioned here on fields of *Taraxacum officinale* cultivated for greens are all found on the same host as a weed in nature. Apparently in the cultivated fields, they do not bother greatly since the fields are usually renewed before they become too conspicuous. The leaf spot trouble shows as round, moderate-size, brownish spots with concentric rings of development and purplish borders, having a more or less evident whitish growth of spore-bearing threads on the under surface. No asco stage is yet known.

Powdery mildew, *Sphaerotheca Castagnei.* This powdery mildew is more or less conspicuous on the leaves in its mycelial and the powdery conidial spore stage. Later the reddish to dark-colored, small perithecia (mature fruiting bodies of the asco stage) are more or less abundantly embedded in the external mycelium. While the mildew has a variety of other hosts, chiefly Compositae, this is the main one reported here. Powdery mildews show their specific characters largely through the microscopic examination of their perithecia. *See* Speedwell.

Rust, *Puccinia Hieracii.* The II and III stages of this rust appear here on the dandelion and endive, and certain related wild species, as the usual, roundish, lighter and darker, reddish-brown, powdery pustules chiefly over the leaves. It is said to possess no I stage.

Dewberry

Leaf spot, *Septoria Rubi.* We have found the trouble on this and related hosts of raspberry and blackberry, both cultivated and wild, in varying degrees of prominence. Generally at least a moderate number of spots can be found on the leaves and less commonly on the young stems. The spots are whitish or light-colored with a decided purplish border and in the center the embedded, black, fruiting bodies of the imperfect spore stage are more or less evident. The mature asco stage appears on the old dead leaves and is known as *Mycosphaerella Rubi* but as yet we have not found it here.

It rarely pays to spray to prevent this trouble but if desired use Bordeaux, with potassium oleate as a sticker, and start in the early season.

Rust, orange, *Caeoma nitens.* This is occasional on the cultivated and common on the wild plants and on practically all the rust is the short-cycled form. *See* Blackberry.

Dill

Black spot, *Phoma Anethi.* This is the only fungus that we have observed on this host and we are not sure that it was more a parasite than a saprophyte. *See* Addenda for further details.

Dogwood

Leaf spot, *Septoria cornicola.* While a number of diseases have been reported elsewhere on different species of Cornus, chiefly of the leaf spot type, so far this is the only one we have determined on cultivated species here. It has been found on two species, *C. paniculata* and *C. sanguinea*, producing more or less abundant spots, light to dark brown at the center and with evident, purplish borders. The embedded fruiting stage in the center is usually not very evident.

The asco stage has apparently never been reported; however, if the disease is prominent, it might pay in late fall to rake up and burn the fallen leaves.

Dutchman's Pipe

Gray mold, *Botrytis cinerea.* We have found this fungus occasionally in wet weather on the leaves of *Aristolochia sipho. See* Geranium.

Eggplant

Early blight, *Alternaria Solani.* This blight is seen occasionally on the leaves of *Solanum melongena* but does little damage. *See* Potato.

Fruit rot, *Phomopsis vexans.* When started in a field during wet weather, this proves a most destructive disease. We reported it years ago as *Phyllosticta hortorum.* It forms occasional, light colored spots on the leaves with an embedded, black fruiting stage but is chiefly injurious and prominent on the fruit usually as it ripens. Here the fungus rots it into a light-brown, gradually increasing zonated area in which finally appear the small, black, imperfect fruiting bodies that when abundant give it a blacker color. No asco stage has been reported.

Practice frequent rotation; keep refuse out of manure pile; use only best seed but if suspicious treat with corrosive sublimate 1 to 1000 for five minutes. Here spraying seems hardly advisable though Bordeaux has elsewhere given good results when used weekly for five treatments.

Gray mold, *Botrytis cinerea.* It is sometimes responsible for rotting the ripe fruit when an evident, grayish growth develops. *See* Geranium.

Seedling rot, *Rhizoctonia Solani.* It is found occasionally in seedlings. *See* Spinach.

Wilt, *Verticillium alboatrum?* We have seen a wilt very troublesome in certain fields but we have never isolated the fungus to be sure that it was this species or a similar Fusarium. In other nearby states, however, this seems to have been done and, as we have found this fungus on potato, it seems to be the reasonable one. There is little on the outside of the infected plants to show the cause of the injury but when the stem is cut open one can see a darkening of the fibro-vascular bundles and usually under the microscope get evidence of mycelial growth and internal production of spores. The first sign of the trouble shows as a somewhat stunting of the maturing plants, wilting and yellowing of the leaves and the gradual death by defoliation of the same from below upwards. The infected plants may be adjacent or scattered over the field and, if bad, little or no crop is harvested. As there seems to be no evident external means of spreading the disease by spores, it always has seemed to us that it did not spread from plant to plant but became general all over the field at the same time. Evidently infection is through the fungus in the soil of the field or it is brought in by infected plants from the seed bed. So far as we know the seed is not the source of infection.

The seed bed should receive the first attention to be certain that it is not the source. Next, frequent rotation should be practiced, avoiding land recently in potatoes and care should be given in the use of manure that might carry or increase the trouble.

Mosaic. This disease is usually not so evident as on other plants and is apparently not serious here. *See* Tobacco.

Scald. We have seen this occasionally on the fruit following very hot weather. *See* Apple.

Elm

Anthracnose, *Gloeosporium ulmicolum.* This new leaf disease is scarcely to be distinguished from the older one described as Black spot, *q.v.* However, only the imperfect stage is known and it is distinguished from the imperfect spores of the other by their larger size. It has been found here during the last few years on *Ulmus americana* and certain of the introduced species and varieties, such as the Chinese or Siberian elm. Early in June, 1933, we received specimens of the Siberian elm where the fungus was fruiting prominently on that year's twigs and advancing into the leaves at their bases through the midribs. Later we received the same fungus on the twigs of the American elm. Evidently the fungus must carry over the winter in the small twigs and thus secure early infection in this way.

Beetle fungus, *Sporotrichum globuliferum.* This fungus, in wet seasons and when elm beetles are abundant, is responsible for causing their death in considerable numbers, thus helping to keep them in check the next season. It can be distinguished by the evident, white growth that covers the dead insects found in the cracks of the bark.

Black spot, *Gnomonia ulmea.* The black spot has been common on the leaves of the American elm for years and has recently been noticed on some of the foreign species. It causes little, black, clustered pimples, evident on the upper

surface of the leaves but less evident and often concave beneath. In these are produced the minute spores that spread the disease during the early season. The trouble is always present in a small way each season but if abundant it causes the leaves to turn yellow and drop prematurely; sometimes the trees are practically defoliated in mid-summer. The infected leaves begin to develop the asco stage while still living, but it never matures until the following spring.

When bad, the old leaves should be gathered and burned in the late fall. If the trees are small or their foliage is highly valued, it may pay to spray them with Bordeaux the next spring, beginning with the developing leaves. Under ordinary conditions and with the variability of its appearance, most people are not likely to give large trees the two or three sprayings necessary.

Canker, *Nectria cinnabarina,* etc. This saprophyte or weak parasite has recently been found on the Mongolian elm, *Ulmus pumila,* in several nurseries of the state in both its asco and conidial stages (*Tubercularia vulgaris*). Where seen by us it appears to be merely a saprophyte on the lower, suppressed and dead branches without injury to the main stem. However, some nurserymen claim it causes death of the living trees, which might really be due to drought or winter injury rather than to the fungus. In some cases, also, the dead tissues show the fruiting stage of *Sphaeropsis malorum,* another saprophyte or weak parasite. *See* Horsechestnut.

Dutch elm disease, *Graphium Ulmi.* One tree badly injured with this disease was found in Connecticut in the fall of 1933. It was destroyed in January, 1934. Whether others will be found in 1934 remains to be seen, but the finding of a second tree in February indicates they will be. ***See* Addenda for further statement.**

Heart and sapwood rots, *Pleurotus ulmarius,* etc. Wood rots are not very evident in this tree but the above in the sapwood and undoubtedly other fungi, such as *Fomes applanatus* in the heartwood, are responsible for the same.

The Fomes species we find in fruit apparently only after the trees have been cut into logs. This is described under Maple.

The Pleurotus is a large, toadstool-like type with a buff-colored top, often cracked at center and with white gills beneath usually notched to the conspicuous, central but often recurved stem. Often it occurs singly.

Another fungus, *Polystictus conchifer* is a small, papery body, often conch-shaped or cupped, with a grayish upper-surface usually coated with dark lines and a white, porous under-surface. While it is probably not responsible for the death of the twigs and branches, it does cause decay in them afterward so that in storms they are usually broken off and become a menace to people travelling beneath the trees.

Leaf spot, *Septogloeum Ulmi.* This fungus was found once on seedlings of Ulmus sp. in Hamden. It produces minute, yellowish to finally reddish brown spots in the leaves on the under surface of which oozes out a conspicuous, yellow globule containing the spores. Some claim it is the imperfect stage of *Dothidella Ulmi.*

Twig wilt, *Cephalosporium* sp. While we have found only two specimens of the Dutch elm disease, *Graphium Ulmi,* which has proved so destructive in Europe, there have been called to the attention of the Station several large American elms in the state that developed a wilt of the smaller twigs and branches somewhat approximate to it in appearance but not in severity. The above name of the fungus causing it has recently been applied to it by another worker.

The trees show a curling, wilting, yellowing and final death of the leaves followed often by the slower death of the twigs and smaller branches. No external sign of a fungus is seen but, on cutting across the smaller branches, one often can find blackish spots in the newer wood. Sections of these, under the microscope, reveal the presence of the mycelium of a fungus, and cultures of it have been obtained. Inoculations on elm seedlings with these cultures made by Dr. McCormick, who is carrying on this investigation, have not as yet revealed this fungus as a very vigorous parasite.

Aerial roots. We have seen large elms, also willows, when the bark had been injured from various causes, that started small, root-like growths from the cambium and in a few cases, running down beneath the dead but finally decorticated bark for a considerable distance, reached the ground, taking hold there as true roots.

We have also seen somewhat similar growths on forest trees that were apparently injured by lightning.

Bleeding and Slimy flux. When elm trees, also some other trees as maples, etc., are injured in various ways in the bark or by cutting off branches, they often start bleeding at these places, especially in the spring in wet weather. It is frequently very difficult to stop this water or crude sap. If it continues the surrounding bark rots as a result. If sufficiently rich in elaborated food material, this sap sometimes develops a mixture of fungi, bacteria and yeasts that thicken the same into the so-called slimy flux. Once a tree starts this bleeding trouble, especially in wet weather, one cannot be sure when it will stop.

So far the chief remedy, if the trouble occurs on the main trunk, is to cut away the injured bark back to the healthy to start a new cambium growth and to insert, a short distance below the injured place, a small pipe to help stop the bleeding and carry away the drip from the bark directly to the ground.

Mechanical injuries. One need not elaborate on the various types of these injuries due to transplanting, removing of needed dirt or filling in to greater depths, unnecessary pruning of limbs and roots, paving of streets, etc. These troubles apply to all street trees to a greater or less extent. One of the most frequent and conspicuous injuries in the past has been due to horses gnawing the bark, but now this can largely be charged to man and his automobile. Many of these bark injuries, through neglect or by repetition, now show large, deep, concentric cankers where the original injury has increased yearly by the dying back of the bark at the edges of the injury.

Endive

Rot, *Rhizoctonia Solani.* We have found the fungus rotting the seedlings and roots of this plant. *See* Spinach.

Rust, *Puccinia Hieracii.* This rust has been seen only rarely on *Cichorium endivia.* *See* Dandelion.

Euonymus

Crown gall, *Bacterium tumefaciens.* This is occasionally reported in nurseries. Apparently *Euonymus radicans* is a very susceptible species. In 1932 we saw specimens in a nursery labeled variety *variegata* that showed a great number of these galls of considerable size growing on the running stems but the injury did not seem as great as one would expect. However, these gall-like growths die much more readily and earlier than the normal tissues. *See* Rose.

Eupatorium

Crown rot, *Sclerotium Delphinii.* The mist flower, *Eupatorium coelestinum,* is another herbaceous plant that recently has been sent to the Station for information because of injury by this sclerotial fungus. *See* Larkspur.

False Dragon Head

Crown rot, *Sclerotium Delphinii.* This fungus, with its evident but small, reddish-brown sclerotia, has recently been found rotting off the base of plants of this western plant, *Physostegia virginiana,* now coming into cultivation in some of our flower gardens. *See* Larkspur.

Ferns

Nematode leaf blight, *Aphelenchus olesistus.* This trouble has been found occasionally on a variety of ferns in greenhouses causing more or less damage. *See* Begonia.

Leaf scorch. The death of the leaves, or parts of the same, shown by the red discoloration in contrast to the normal green color, has occasionally been seen in greenhouses on the delicate ferns of the Maidenhair type. The injury is similar to

that caused by the preceding disease but without any evidence of nematodes. It is evidently due to lack of proper shading or watering at certain times during hot or dry weather.

Fir

Gray mold, *Botrytis cinerea.* We have occasionally seen this trouble on the very young leaves and twigs of large trees of Douglas Fir, *Pseudotsuga Douglasii* that have been killed in the wet weather of spring. It does not seem to be progressive after the leaves mature. We see no reason for considering it as a species distinct from the common gray mold found on a variety of cultivated plants under similar conditions, though some call it *B. Douglassii. See* Geranium.

Firethorn (Scarlet)

Scab, *Fusicladium pyrinum* var. *Pyracanthae.* This fungus was sent to Dr. Marshall by Dr. Felt of the Bartlett Tree Expert Co., and turned over to the writer for determination. It is the first time the fungus has been listed from the state and apparently for the United States on this host, *Pyracantha coccinea* (*Crataegus Pyracantha*). This fungus was evidently objected to by the grower because it spoils the scarlet color of the berries in the fall. It has been listed previously at least in France and Germany under the same name, and our specimen agrees with exsiccati specimens from those countries. A Fusicladium also is listed by Saccardo under *F. dendriticum* (the apple scab) as var. *orbiculatum* on this host as well as on two other hosts. Cladosporium and Venturia, however, have been reported in the United States as occurring on species of Crataegus. The fungus is unquestionably related to the pear, apple and peach scabs but needs special study to determine its exact relationship. It forms evident, circular, olive-black spots on the fruit but is apparently not so abundant or conspicuous on the leaves, at least in our specimens.

While it would seem that late summer and fall sprays would control the trouble, it might be necessary to also make these in the spring as for apple scab.

Flax

Crown rot, *Sclerotium Delphinii.* Complaint was made of this trouble rotting off the plants of an ornamental flax in a nursery in the late spring of 1933. While we did not collect the fungus on this plant, on account of the dry condition when we visited the nursery, we did find it there on monkshood.

Rust, *Melampsora Lini.* This rust was found sparingly in its II stage on experimental plants of *Linum usitatissimum* in October, 1924, at the Station farm. It has been found causing more or less damage of this cultivated flax in North Dakota.

Flowering Crab

Rust, *Roestelia pyrata.* On flowering crab, especially that known as Bechtel's, *Pyrus ioensis*, this rust becomes very abundant even when a considerable distance from the infected cedars. *See* Apple.

Flowering Currant

Bitter rot, *Glocosporium ribomaculans.* This has been seen once on the fruit of the yellow, flowering currant. *See* Apple for details.

Blister rust, *Cronartium ribicola.* It is not uncommon in its II and III stages on the yellow currant, known as *Ribes odoratum. See* Currant.

Foxglove

Anthracnose, *Colletotrichum* sp. We have a single collection of this fungous disease made in July, 1916, on *Digitalis purpurea* at Norfolk. The very small, circular spots are brownish with an evident, reddish border and are most apparent on the upper side of the leaves. We have found no description of this disease attached to a specific name although a Colletotrichum has been reported by the U. S. Disease Survey from Massachusetts. Species of Ramularia and Gloeosporium on this host have been reported from Europe with somewhat similar spores but the spots they cause and the lack of setae, very evident on our specimens, seem to indicate their difference.

Stem-Leaf nematode, *Tylenchus Dipsaci.* Here we have a trouble, collected in 1916 by the writer on the variety of foxglove known as *alba* as a possible fungous disease, that recent examination shows, as determined by Dr. Steiner, to be due to the nematode given above. The spots in this case are reddish-brown, small (2-3mm), angular and abundant on the leaves, fusing more or less in the region of the midrib. According to Steiner foxglove is a new host for this species. He also states that specimens of this nematode have been revived up to four years after drying out. While our specimens seemed to be in fair shape and swelled out and uncoiled after infected pieces of the leaves were kept in water for a few days, we did not succeed in reviving any of them. *See* Phlox.

Fuchsia

Mosaic. Besides an undetermined leaf spot, this is the only disease we have seen on this plant which apparently has few fungous enemies elsewhere. Even the mosaic, similar to the ordinary yellow-green and normal green mottling of other infected plants, has rarely been seen here. *See* Cucumber for this trouble.

Gardenia

Nematode rootknot, *Heterodera radicicola.* In 1915 this trouble was reported on *Gardenia florida* from a greenhouse in Ridgefield. *See* Cucumber.

Undetermined trouble. Recently there was brought to our laboratory injured specimens of Gardenia from a greenhouse in Massachusetts but the person who brought them said a similar trouble had been seen in Connecticut. The stems were cut off above the ground and showed some injury but whether this occurred on the roots we could not tell. The most evident injury was to the leaves which turned brown and then finally black, usually starting at their base while the upper part was still green. We could find no sign of bacteria or fungi in the plant tissues but the fibrovascular bundles seemed to be the parts first affected as shown by their discoloration. It looked to us, so far as we could tell from the specimens, like a soil trouble of some kind. The man who brought in the specimens later wrote concerning the firm that had a similar trouble in Connecticut, as follows:

"This firm had occasional, isolated plants that showed this condition. It did not, however, spread in their case and when they discovered a plant in this condition they pulled it up. I learned from them that at one time this trouble was more or less prevalent with certain greenhouses on Long Island and it was, apparently, traced to the use of German peat moss which was spread on the surface of the bed. When the moss came in contact with the stem of the plant and became watersoaked through frequent watering, it seemed to kill the stem at that point."

Geranium

Bacterial leaf spot, *Bacterium Erodii.* Considering its frequent cultivation and the great variety of forms, there are comparatively few troubles reported here or elsewhere on the various species of Pelargonium. This bacterial disease of the leaves is one of two reported so similar that we are doubtful to which it belongs, providing they are really distinct. We are using the name which was given the first one. The trouble shows chiefly on the leaves as small but numerous, round or angular, reddish spots, pellucid and thin when wet but in time puckered and blackish. It often causes the leaves to turn yellow and drop off. It has been seen in different years in outdoor beds at various places, sometimes spoiling their entire appearance. Usually it has looked as if the trouble came from infected stock grown in the greenhouse before transplanting into the beds.

Growers should be careful to propagate only from entirely healthy plants and the purchaser should plant in a new situation if he has had trouble recently. If one

sees the trouble at its very start, it might pay to pull off and destroy the few infected leaves and give the plants one or two sprayings with Bordeaux.

Gray mold, *Botrytis cinerea.* Besides on this host, the gray mold (also sometimes called scientifically *B. vulgaris*) is listed on about twenty-five other hosts given here and under the right conditions it might be found on many others. These conditions are abundant moisture and heat in the presence of tender foliage and stems or matured fleshy parts.

While not a serious parasite under most conditions, the above conditions and its tendency to fruit as a saprophyte on decaying vegetation make its appearance readily available for injury to the tissues of many plants. There may be some difference of opinion as to its being just one species on all of these hosts, since it is somewhat variable in artificial cultures and other species have been recognized by some on certain hosts.

The fungus has the habit of producing scattered or abundant, dark, fruiting threads, with a cluster of lighter colored spores at the top, over the surface of the infected host. Occasionally on the host and especially in artificial cultures of certain strains, one finds developed small, flattened, black sclerotia that are adapted for carrying the fungus over unfavorable conditions.

In the past certain European botanists, as deBary, believed that this fungus was connected with the Ascomycete known as *Sclerotinia Fuckeliana* and then later botanists, failing to get this fungus from the sclerotia but only the Botrytis, decided that it was not. Brooks, in his Plant Diseases, who has given us one of the best discussions of these two genera, seems to indicate that some of the strains, under certain conditions, may show this relationship.

Control measures are largely sanitary, such as: preventing in leaky greenhouses drops of water falling on the plants; removal of plant rubbish to prevent propagation of spores; avoidance of excess moisture in watering the plants, especially in damp cloudy weather; proper ventilation.

Oedema. We have seen pimply swellings on the leaves of geraniums that we thought might be due to a lack of proper water transpiration and so a trouble of this sort, but possibly they were caused by something else. *See* Oedema under Glorybush.

Ginseng

Blight, *Alternaria Panacis.* While we have never collected this fungus, one of the growers stated some years ago that he had been troubled with it in his seed beds where he grew *Panax quinquefolium.* So little ginseng is grown in the state, and apparently still less than formerly, that we know little of the numerous troubles that have been reported elsewhere where it is grown more commonly.

Downy mildew rot, *Phytophthora cactorum.* We saw this once on the roots of cultivated ginseng in the northern part of the state many years ago. *See* Pear.

Nematode rootknot, *Heterodera radicicola.* This nematode trouble was reported in 1916 as causing considerable trouble in the seed beds of a grower of ginseng at Hamden.

Gladiolus

Bacterial spot (Stem rot), *Bacterium marginatum.* This gladiolus trouble was first collected by us in a private garden in Fairfield in 1925 where it was rather bad. It was not seen again until 1932 which seemed to have been a very favorable year for its development as well as of injury caused by thrips. The corms grown in 1932 also showed the trouble when planted in 1933. The bacteria produces small, reddish-brown, subcircular spots, or more elongated as limited by the veins, on various parts of the leaf and stem but especially numerous below. On the sheathing bases these spots may run together as a general, reddish discoloration and cause a rotting of the softer tissues in wet weather. The disease is carried on the corms by isolated, reddish-brown, circular spots of variable size that finally become sunken in the dried, healthy tissues and are very similar to the hard rot fungus except there is no sign of any fruiting stage.

Treatment of the bulbs with mercuric compounds or formalin is said to have given some beneficial results in preventing the trouble. Badly diseased corms should never be planted. Rotation should be practiced especially where the disease has proved troublesome.

Dry (Sclerotial) rot, *Penicillium Gladioli.* This is a storage rot of the corms. *See* Addenda for further data.

Hard rot, *Septoria Gladioli.* The hard rot fungus is also carried by the corms and its presence is indicated by the reddish rather than blackish, hard rot-spots. On these the embedded, small, black, fruiting pustules are not usually very conspicuous.

Plants from the infected corms under favorable conditions often produce dwarf, yellowish plants with poor foliage and blossoms. On the discolored spots of the leaves, the pustules of this imperfect fungus also may appear in its only known stage. Premature death, before or at blossoming time, may occur to plants most seriously injured.

One should purchase or save only good, sound corms and, if the disease has appeared in the field, plant in a new locality. Treating the corms does not seem to have yielded very encouraging results.

Stem rot, *Fusarium* sp. We have had one case of stems of this plant rotting at the base, evidently caused by a Fusarium. *See* Aster.

Glorybush

Oedema. This, sometimes called intumescence, is usually an excrescense on the leaves or stems induced by too great turgor in the tissues. The development of enlarged and rapidly growing cells often ends in their rupture and then the excrescences may act something like stomates or lenticels. The turgor is induced by too rapid absorption of water, with their fertilizing elements from the soil, without proper loss from the leaves. This occurs especially in cloudy or muggy weather or when trimming of the foliage is made at an unfavorable time especially with strong root pressure. We have seen this trouble only once on the leaves of this host, *Tibouchina semidecandra* var. *floribunda* (*Pleroma splendens,* see Bull. 222: 460). It appeared as evident, ruptured, whitish pustules on the upper side of the new leaves of a house plant that was severely cut back. Somewhat similar ruptures have been reported on the stems of yews similarly treated. Growth cracks are perhaps somewhat similar phenomena especially in the case listed here under snapdragon.

We know, as yet, too little about such troubles and especially the environmental conditions that favor them because the injury is often not evident until the causes have disappeared. Somewhat similar troubles are mentioned here under cabbage, geranium, honeysuckle and yew.

Goldenglow

Drop rot, *Sclerotinia sclerotiorum.* This is seen rarely on the cultivated form of *Rudbeckia laciniata* but when present causes serious injury to the infected stalks. *See* Lettuce.

Powdery mildew, *Erysiphe cichoracearum.* Powdery mildew is found occasionally in its conidial stage on the leaves. *See* Phlox.

Goldenseal

Gray mold, *Botrytis streptothrix?* Over a dozen years ago we had complaint of a fungous trouble in a seed bed where the grower was raising *Hydrastis canadensis.* The leaves and base of the stem were injured by a severe rot of the soft tissues. Our remembrance is that the Botrytis fungus causing the injury made very little, evident, external growth of the fruiting stage except possibly when the leaves were kept moist. The sporophores were peculiar because their terminal branches were wavy or nodose in character. On the rotting or watersoaked tissues of the leaves one could sometimes find the small, black sclerotia that also readily appeared in artificial cultures. This trouble seems to be fairly common where these plants are cultivated. We use the scientific name questionably since Whetzel writes to us that he thinks the fungus on this host deserves specific distinction.

Care in keeping the plants rather dry, removal of the rotting rubbish and spraying in time with Bordeaux should lessen this trouble.

Mosaic. At the same time and place, Mt. Carmel, a few of the plants in the beds mentioned above showed light and dark green mottling of the leaves typical of mosaic. While no inoculation experiments were conducted, it seemed to be of the infectious type.

Gooseberry

Anthracnose, *Gloeosporium Ribis.* Anthracnose on cultivated gooseberries, Ribes sps., is not common or serious. *See* Currant.

Leaf spot, *Septoria Ribis.* The leaf spots on cultivated and wild red and black currants and gooseberries all probably are due to the same species, though on the latter it is sometimes called *S. Grossulariae.* On both types of hosts it forms on the leaves small, grayish to brown spots, with a purplish border, which vary somewhat in size. On these spots is formed, more or less abundantly, the imperfect stage which shows as small, black, embedded bodies.

Usually no spray treatment is necessary because of the small injury involved. Raking and burning the old leaves may pay since on these the asco stage, known as *Mycosphaerella Grossulariae,* is found in the early spring.

Powdery mildew, *Sphaerotheca Mors-uvae.* This mildew is not frequently found here though years ago it was evidently more common and caused serious loss especially on English varieties of gooseberries. It has been found a few times by the writer on gooseberries and once on both cultivated red currants and the wild skunk currant. Usually the mycelium forms a dirty-white felt, rather than a powdery growth, of the mycelium and summer spores and this is apt to cover the young stems and leaves but on the gooseberry it is sometimes largely limited to dense patches on the fruit. Embedded in this growth are the perithecia containing the winter spores of this Ascomycete (Fig. 33).

Spraying as for anthracnose of currants, *q. v.*, should take care of this trouble when necessary.

Scald. In very hot weather we have seen the fruit so badly injured that it looked as if baked and most of the berries fell off. *See* Apple.

Gourds

Anthracnose, *Colletotrichum lagenarium.* The anthracnose is seen only occasionally on the fruit of various gourds (Luffa, etc.) *See* Watermelon.

Downy mildew, *Peronoplasmopara cubensis.* It was seen once on bottle gourd, *Lagenaria leucantha. See* Muskmelon.

Powdery mildew, *Erysiphe cichoracearum.* The mildew occurs occasionally and is found so far only in its conidial form. *See* Phlox.

Grape

Bitter rot, *Gloeosporium rufomaculans.* It has rarely been found here on the fruit of Vitis sps. *See* Apple.

Black rot, *Phyllosticta Labruscae.* This trouble is so-called because on the fruit it produces a rot that results in the berries becoming shriveled into black mummies adhering more or less firmly on the bunches, which may be entirely or only partly infected. The fungus also invades the young, tender, woody tissues to a less degree. On the leaves the disease shows as distinct, reddish-brown spots in which the small, black, fruiting bodies of the imperfect stage are embedded showing even more evidently than on the fruit and twigs. The next year the infected tissues, at least in the mummied fruit, mature the saprophytic asco stage known as *Guignardia Bidwellii* and now commonly applied to both stages. We have never looked carefully for this mature stage but it is probably the chief cause of the new spring infections. The same imperfect fungus occurs here on the Boston ivy and Virginia creeper, where it is conspicuous chiefly on the leaves. (Fig. 34).

Bordeaux mixture has proved the best fungicide in the control of this fungus but should be started with the beginning of leaf development and be applied every seven to fourteen days up to the middle of July, when further sediment on the fruit may hinder its sale.

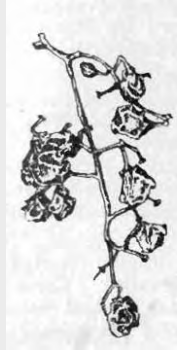


FIGURE 34. Grape black rot.

FIGURE 35. Hollyhock rust.

FIGURE 36. Ivy black rot.

Blue mold, *Penicillium expansum.* This is found common in storage on fruit of grapes, apples and pears and is considered different from the similar appearing blue mold on citrus fruits called *P. digitatum,* also common here. It is an imperfect fungus that rots the fruits and breaks through the ruptured skin as tufted, fruiting threads that bear a multitude of small spores, blue-green to olive-green according to age. Apparently the asco stage of this particular fungus has not been discovered although other species are known to have such a stage.

The fruit should be stored in a cool, dry place and subject to inspection for removal of the rotted ones. Sprayed fruit apparently is less likely to rot from this fungus.

Crown gall, *Bacterium tumefaciens.* This has been seen here only rarely on grape and then on tropical, greenhouse grapes where the base of the vines developed numerous, rather prominent galls, rather than simple hard ones, that early rotted away. We originally thought it was a winter injury. *See* Rose.

Downy mildew, *Plasmopara viticola.* We have found the downy mildew as early as the last of June but usually it becomes most conspicuous after the middle of August. It is common on the wild as well as on cultivated varieties of grapes. It forms reddish spots on the upper surface of the leaves varying in shape, size and grouping according to the outgrowths of the immature or summer fruiting-stage beneath. This consists of minute, white, tree-like threads issuing through the stomates or pores of the leaves and having bunches of temporary spores at their tips. These threads may be scattered or grouped in a dense growth that stands out prominently if the white hairs of the leaves of certain varieties do not obscure it. This conidial growth may also appear on the young tender tissues of the twigs, tendrils, pedicels of the fruit and even on the green grapes. After the grapes begin to ripen, especially white varieties that seem more susceptible, the mycelium of the fungus may develop a brown rot without external appearance of the fruiting stage.

The winter stage produces larger, thick-walled, spherical spores borne singly in a sack and embedded in the plant tissues. These spores are usually difficult to locate but serve to renew the fungus the next year. Next to the black rot, this mildew causes the most serious fungous injury to our grapes and is even more frequently present causing minor injury.

Spraying for the black rot should ordinarily control this trouble as well. However, in this state, it rarely pays to spray for this trouble alone.

Gray mold, *Botrytis cinerea.* We have found this chiefly on greenhouse grapes where it forms a rather dense matted growth on the fruit. *See* Geranium.

Powdery mildew, *Uncinula necator.* Usually this *powdery* mildew, as contrasted with the *downy* mildew, becomes common in the late summer, appearing on the leaves and less frequently on the pedicels and fruit of the grapes. *See* Virginia Creeper.

Lightning injury. We have seen injury due to lightning which apparently hit the wires on which the grapes were trained and passing down the stems into the ground killed the roots directly. Later the vines slowly died indirectly as a result of the root killing. See similar injury reported elsewhere on trees and shrubs.

Shelling. The green and ripening grapes in certain seasons fall off the bunches, sometimes without evident indication of insect or fungous injury. The downy mildew, causing the brown rot of white grapes, is sometimes the cause of this trouble but it can be identified as the cause. Other less easily identified causes may be due to variable weather, affecting growth of the vines, or to the condition of the soil regarding the availability of certain mineral constituents. *See* Rept. 1896:278 and 1906:315.

Smoke injury. We have had several complaints where injury resulted from smoke from brick yards when certain weather conditions prevailed. These conditions include the presence of coal in burning the bricks and a good volume of smoke which instead of going up into the air is driven along the ground in the direction of the grapes, the leaves of which are wet with dew or rain, when a more or less extended, reddish-brown scorch results. Similar scorch to the leaves of other plants may result under like conditions, complaint having been made for various trees (especially conifers, maples and fruit trees) and a few vegetables such as asparagus. The injury results from the sulphur dioxide of the smoke uniting with the water on the leaves to form sulphurous or sulphuric acid that produces the burn.

Winter injury. This trouble usually results from killing the roots in too wet soil or, in severe winters, when a snow or other mulch is lacking to protect the roots. The vines may not show the injury until they leaf out or even later when the leaves begin to die as a result of this severe or fatal injury to the roots.

Groundcherry

White smut, *Entyloma australe.* We have occasionally found this smut on the leaves of cultivated species of *Physalis pubescens* and on various wild species of the same genus. It has also been found here once on the Chinese lantern. The smut produces yellow, discolored spots on the upper surface of the leaves with finally a white conidial growth on the lower surface. The light-colored, permanent spores are embedded within the tissues. It usually is not injurious enough to need any treatment.

Mosaic. This has been found on wild species of Physalis. As this perennial weed can carry the mosaic over the winter, it is no doubt the source of infection to some of our cultivated crops by means of lice carriers. *See* Cucumber.

Hawthorn

Fire blight, *Bacillus amylovorus.* This has been seen chiefly on the English hawthorn, *Crataegus Oxyacantha,* and on trees whose blossoms when abundant favored visitation by bees. *See* Pear.

Leaf-fruit blight, *Entomosporium maculatum.* On this host the blight has been seen so far only on the leaves of the English hawthorn and it does not usually cause severe injury. *See* Quince.

Rust (leaf), *Roestelia globosa.* The rust occurs here chiefly on the leaves of the various wild hawthorns but is also found occasionally on the apple and mountain ash and rarely on the pear. It develops the O-I stage on these hosts. The cluster cups are more elongated than with the common apple rust and split into elongated threads that wear away gradually rather than the recurved ones fringing the edges of the cups of *R. pyrata.* The III stage occurs on the cedar and is called here a cedar-hawthorn rust, *q. v.*

Rust (stem), *Roestelia aurantiaca.* We find this rust rather common on the fruit and small twigs. *See* fruit rust of Quince.

Hazelnut

Knot, *Cryptosporella anomala.* So far this trouble has been found only occasionally in nurseries on the European hazelnut or filbert, *Corylus avellana.* It is distinct in its appearance since it develops, in its final form, one or more rows of small, oval galls on the branches. These break through the bark enclosing them at the base and on their tops show the numerous black, embedded pustules of the asco stage.

One should cut off and burn the infected branches a considerable distance below the outbreaks. The trouble is so infrequent that spraying does not seem to be necessary.

Hemlock

Rust (cone-stem), *Melampsora Farlowii.* Of the three rusts described here, this is the only one that has its III stage on the hemlock, *Tsuga canadensis,* and so far it is the only known stage. It develops on the scales of the cones and the small twigs, rarely running up into the leaves, and produces small, embedded, reddish blisters composed of a layer of permanently united spores. It has very rarely been found here and does no particular damage. The rust was originally made the basis of a new genus, Necium, and differs from our species of Melampsora in that it lacks the II stage that accompanies the III stage on the same host.

Rust (Hemlock-Blueberry), *Peridermium Peckii.* This rust in the I stage occurs in early summer only on the leaves of this year's growth. It is evident through the very definite, white peridia that stand up in a row on either side of the midrib. Often only a single leaf on the small twig is infected. The peridia split open irregularly from the top disclosing the dusty, orange spores which are carried to the blueberries and related hosts and there develop the II and III stages of the rust which is then called *Pucciniastrum Myrtilli.* *See* this name under Azalea.

Rust (Hemlock-Poplar), *Cacoma Abietis-canadensis.* The I stage of this rust occurs in June and July on the leaves, cones and tips of the very young twigs of this host. The outbreaks usually develop sparingly on the leaves, are most evident on the cones and may cause slight distortion of the twigs. They show slight evidence of the cups or peridia, being small blisters beneath the skin that rupture and disclose the orange mass of spores. Little damage is caused the host. The II and III stages, known as *Melampsora Abietis-canadensis,* occur on the poplar, *q. v.*

Abnormalities. We saw some years ago a native hemlock that a farmer had transplanted in his yard because of the peculiar, somewhat curled tip of the young twigs. He wished to know what caused this peculiarity. While we examined these twigs for signs of a fungus, we could not be sure that it was the result of injury of that type.

More recently we had sent to us specimens of hemlocks that instead of a main stem made a great number of smaller stems giving a bushy effect. The man wished to know if the same could be propagated by cuttings or grafts.

These cases led us to consult a nursery firm where abnormalities of this type are saved. They have found that in the culture of their seedlings a few of them vary from the normal type. So they save these by themselves when transplanting and if they continue to maintain their abnormality they sell them as such at special prices. In this way they have accumulated quite a variety of forms, usually of the more dwarfed and bushy types. They were not very successful in perpetuating these types by cuttings and as yet were not sure of the results of grafting. Some of such variations are sold by other nurseries under special names describing some type of their variation. These, possibly, have become so fixed that they can be propagated true to type.

Hickory

Anthracnose, *Gloeosporium Caryae.* This fungus causes conspicuous, purplish or reddish-brown spots showing on both surfaces of the leaves of Hicoria sps. and on the lower side develops the minute, more or less evident, fruiting bodies that ooze out the spores of this imperfect stage. The perfect asco stage, known as *Gnomonia Caryae,* is found on the old fallen leaves. The disease is not uncommon on the trees in the woods.

Witch's broom, *Microstroma Juglandis.* The white mold, as it is more commonly called on the leaves, is said to cause this type of trouble on the branches of hickory; for description *see* same under Butternut.

Wood rot, *Fomes connatus.* This fungus is found on the living hickory and some other trees, as maple and poplar, and is variable in size from two to several inches across, according to age. It consists of one to several, overlapping es grown more or less together to form this, at first soft but finally corky, or even woody, Basidiomycete. These fruiting bodies, especially at the edge, are colored light-brown but with age may become blackish, while the lower, porous fruiting surface is a flesh color. When cut across, the superimposed layers of the annual spore-tubes can be made out.

Hollyhock

Leaf spot, *Cercospora althaeina.* Occasionally this fungus produces numerous spots on the leaves of *Althaea rosea* causing serious injury. These spots are small, chiefly an eighth or less of an inch across, angular and light to reddish-brown in color. On the under surface, some indication of the imperfect stage can be seen growth of the dark-colored, fruiting threads and spores. The stage is apparently unknown. The treatment is the same as for next disease.

Rust, *Puccinia malvacearum.* This is our most common disease of the hollyhock and is frequently sent to the Station for identification. The rust forms its only stage (III) as pustules on the leaves, chiefly beneath, and on the pedicels and stems. They are firm, roundish cushions of spores of a reddish-brown color. These spores usually germinate as soon as formed in the pustules and then they have a whitish or gray color. The rust may appear early in the spring and extend into the early winter on protected plants. (Fig. 35.)

The old stems and leaves should be gathered up carefully and burned. Then in the spring, as soon as the plants begin to appear above the ground, they and the ground about them should be thoroughly sprayed with Bordeaux and the treatment repeated a few times at intervals of 7–14 days.

Honeysuckle

Crown gall, *Bacterium tumefaciens.* On species of Lonicera the crown gall has been found occasionally in nurseries. *See* Rose.

Gray mold, *Botrytis cinerea.* This common mold has been collected occasionally on outdoor plants in wet years. *See* Geranium.

Leaf curl, *Glomerularia Lonicerae.* This imperfect fungus we call a leaf curl on this host because of its similarity to the effect produced by Exobasidium on its hosts. The former shows a short, white growth of its conidial spores and conidiophores more or less general on the under side of the leaves. We collected it once, and it was also sent in for examination in 1932 on cultivated shrubs of *Lonicera canadensis.* It has been reported only a few times on cultivated Lonicera but a similar species has been found on *Cornus canadensis* in the woods. Formerly both were considered the same species, known as *G. Corni,* but the one on Lonicera later was separated as a distinct species, as given above. Little is known about its life history.

When the disease is not abundant, cutting off the infected twigs should take care of it. If it becomes general on the shrubs, it may be necessary to spray beginning in the spring before the leaves show its presence.

Powdery mildew, *Microsphaera Alni.* Both conidia and perithecia have been found on undetermined species of this host. *See* Lilac.

Oedema. In 1927 specimens of cultivated honeysuckle were sent to us where, the old stems having been winter killed, the new stems showed loose, gall-like swellings with ruptured cells. Evidently the winter injury had not extended to the roots so that they supplied water too freely to the new stem growth. *See* Glorybush.

Hornbean (Blue Beach)

European canker, *Nectria galligena.* We have found this fungus rarely on *Carpinus caroliniana* causing cankers on forest trees. *See* Birch.

Horsechestnut

Bitter rot, *Glomerella cingulata.* Both the imperfect stage and the asco stage of this fungus were found once in Meriden on the living leaves of this host. *See* Apple.

Canker, *Nectria cinnabarina.* This stage and its imperfect stage, *Tubercularia vulgaris,* have been found on dying trees, primarily injured by severe winter weather, at Norfolk and elsewhere. *See* note under cane blight of currant.

Leaf blotch, *Phyllosticta Paviae.* The European horsechestnut, *Aesculus Hippocastanum,* is very susceptible to this disease which usually appears here each season but in favorable ones becomes serious. However, we have never seen a tree die as a result of repeated injury. The injury is chiefly to the foliage and when severe premature defoliation may take place long before the usual time. The infected leaves develop conspicuous, reddish-brown spots or areas of greater or lesser extent that eventually may kill them. On these can be seen the small, black, embedded fruiting bodies of the imperfect stage named here. The small spores ooze out on the leaf surface and spread the disease to other leaves. If the season turns very dry after infection, as in 1931, these fruiting pustules often fail to appear on some of the leaves and then it is difficult to tell the trouble from an ordinary sun scorch.

It is from the old dead leaves in the spring that reinfection apparently takes place through the maturing of the asco stage, called *Guignardia Aesculi.* In the fall these old leaves should be raked together and be burned. Spraying the next year should begin on the young developing leaves and should be repeated two or three times until the first of July.

Powdery mildew, *Uncinula flexuosa.* Like all the powdery mildews, this species develops its mycelium and conidial stage as a white, superficial growth over the leaves, in this case chiefly on the upper surface. The perithecia of the asco stage are small, blackish, superficial bodies and are not usually very abundant. The characteristics of the genus *Uncinula* are the hooked, slender appendages that hold the perithecia to the mycelium. With this species, *flexuosa,* these appendages are wavy at their outer half. Both of these terms are indicated in the scientific name *Uncinula flexuosa.* Normally this is not a trouble that needs attention by spraying in Connecticut.

Winter injury. Occasionally species, not adapted to the climate this far north especially when the winters are severe, have been killed or show injury to the buds or by cankered areas on the limbs. Certain semi-parasitic or saprophytic fungi may later develop on these and thus obscure the real cause of the trouble.

Removal of the badly injured trees, cutting off the injured branches and, where needed, spring fertilization to secure new growth are the only treatments required.

Horseradish

Bacterial leaf spot, *Bacterium campestre* var. *Armoraciae.* This was first seen on *Radicula Armoracia* at Silver Lane in 1928 about the time the disease was found and described elsewhere. It occurred only on a few plants in a large field but was conspicuous on these. The bacteria produced numerous, small, reddish-brown spots that often ran together into larger ones. At first the spots were most conspicuous on the under side of the leaves. They were often bounded by a darker line along the border. Seen by transmitted light, the spots showed as hyaline areas, as if all

the tissues between the epidermal layers had been destroyed. The disease is caused by a special variety of the bacterium of black rot of crucifers mentioned here. Little apparently has been done concerning treatment anywhere.

Black leaf spot, *Alternaria Brassicae.* While this has been called by several others *Alternaria herculea,* it is doubtful if it is distinct from the Alternaria common on crucifers as given here. *See* Cabbage.

Leaf spots, *Cercospora Armoraciae, Ramularia Armoraciae.* These are two other leaf spots that can usually be told from the preceding by their lighter-colored, smaller spots usually without evident rings of growth. They are very similar to each other and produce whitish to grayish, fruiting threads on the surface of the leaves that need to be examined microscopically to distinguish them. Sometimes these infected spots fall out giving a shot-hole effect to the leaves. As yet no asco stage has been reported for either fungus, although the Ramularia is said to produce sclerotia on the leaves that carry it over the winter.

Little has been done to control the three leaf spots but if necessary destruction of the foliage in the fall and spraying in the spring or early summer should help.

White rust, *Albugo candida.* This fungus produces white, roundish, irregular blisters on the leaves and frequently on the stems of certain of its hosts. These blisters are the conidial stage of the rust which, despite its looks, is a close relative of the downy mildews rather than a true rust. The growth of the pustules ruptures the epidermis of the leaf and the white, powdery spores are scattered and on germinating spread the disease. The winter stage is composed of colored, thick-walled spores, similar to those of the downy mildews, that are embedded in the tissues of the host. Besides the horseradish, the radish is the only other of the cultivated crucifers upon which we have found this fungus, though it is common on certain of the weeds. So far, little injury has been observed to either of these plants.

Mosaic. This has been seen rarely in cultivated fields but as the host is perennial the disease will probably appear each year on the same plants and so be a menace to other plants. *See* Cucumber.

Hydrangea

Chlorosis. The only trouble we have seen on this host, besides an unidentified leaf spot, has been a chlorosis of the same. The whitish mottling of the leaves was of varied designs and of unknown origin. It did not seem to be merely a variegated variety and apparently was not a true mosaic.

Iris

Bacterial soft rot, *Bacillus carotovorus.* The bacterial soft rot was first observed and mentioned in Connecticut on *Iris germanica.* The rootstocks rotted in the ground and caused the leaves and flowers to turn yellow and die. Sometimes the rot extends to the bases of the leaves. With most of the hosts, this bacterium usually attacks the fleshy parts under or in contact with the soil; such as roots, rootstocks, tubers and sometimes the leaves and fruit. It may follow injuries by animals or other bacterial injuries, when soft rot follows black rot of cabbage, or even fungi, when soft rot of potatoes follows late blight in the tubers. Abundance of humus in the soil and wet weather favor infections since they increase the development of this saprophytic bacterium in the soil.

The hosts injured here, so far as noticed, are as follows: cabbage, calla lily, carrot, cauliflower, celery, Chinese cabbage, cucumber, lettuce, muskmelon, pepper, potato, radish, salsify, squash, tobacco, turnip.

Poor storage conditions at unfavorable temperatures (too high or too low), especially winter storage in too deep piles without proper ventilation or storage in trenches out of doors, are contributing factors for infection of harvested crops. All of these contributing factors should be looked after carefully. If ornamental plants are in too wet soil, the healthy ones should be removed to higher ground.

Bacterial spot, *Undetermined bacteria.* In 1922 specimens of a bacterial disease of cultivated iris (apparently *I. germanica*) were gathered by Stoddard at Bantam.

It was rather prominent on the leaves. They had a watersoaked appearance with elliptical to elongated, somewhat irregular areas lengthwise between the veins especially at the margins. The spots when dry were light brown with some indications of purplish borders. We have never seen a trouble quite like this since (and so far as we know it was not associated with a rot of the rootstocks) unless it was on *Iris pumila* where bacteria, as well as a little of the leaf spot reported below, were present. In July, 1933, we found the same or a very similar bacterial leaf spot in a nursery at Greens Farms on *Iris cristata* where it was especially bad. The infected areas were very variable in size and shape, having at first a watersoaked, lighter green appearance then running more or less together and turning a light to dark brown. Bacteria were very abundant in the tissues and where the whole leaves were invaded they soon dried up and died.

Crown rot, *Sclerotium Delphinii.* Occasionally this fungus has been found rotting these plants, including *Iris cristata, I. germanica,* and some of the Japanese species. *See* Larkspur.

Leaf spot, *Heterosporium gracile.* This imperfect fungus causes small, oval, yellowish, watersoaked and then grayish to brownish spots with purplish borders on the leaves. If abundant, it causes the leaves to turn yellow and die prematurely. The fruiting stage shows as small, blackish, fruiting threads erect on the infected spots. The asco stage is claimed by Tisdale to mature on the old dead leaves and stalks as the fungus known as *Didymellina Iridis,* but later Klebahn claimed it as a new species, called by him *D. macrospora.* The disease has been found on the German Iris the most commonly of any of the species. It has been found also on *Iris pumila.*

All the old leaves should be gathered in the fall and burned. If desired Bordeaux, with the potassium-oleate sticker, can be applied to the new growth in the spring and early summer as needed.

Root rot, *Rhizoctonia Solani.* We have found the fungus rotting the roots of this plant. *See* Potato.

Rust, *Puccinia Iridis.* This rust is common on our wild species of Iris and has been found here on the occasionally cultivated *Iris versicolor* and on *Iris hexagona.* So far, only the II stage has been found, showing as very small, oval or elliptical pustules chiefly on the leaves. These frequently cover the surface of the leaves and, on rupturing the epidermis, show as reddish-brown, dusty masses of spores. The III stage is said to occur only in the far west and the I stage is unknown.

Its rare appearance on cultivated species makes unnecessary any preventive treatments other than the removal and destruction of the old dead leaves and rubbish in the late fall.

Ivy, Boston

Black rot, *Phyllosticta Labruscae.* The imperfect stage as given here is seen not uncommonly as the reddish-brown spots on the leaves. *See* Grape. (Fig. 36.)

Seedling root rot, *Rhizoctonia Solani.* This trouble was seen in a nursery where peat was used on the seed bed and the acid reaction favored the development of this fungus. *See* Spinach.

Winter injury. This host, *Ampelopsis tricuspidata,* is much less subject to winter injury than the English ivy. However, we have seen injury on the north side of a brick building when a severe winter injured or killed the vines. With some of the horizontal branches, the injury was confined to the uppper side, the lower being still alive. When the injury was not too severe, the leaves showed the trouble only after the beginning of the hot summer weather.

Ivy, English

Leaf spot, *Phyllosticta* sp. This trouble on *Hedera helix* has been reported several times by the nursery inspectors but specimens are not available at present for study. Two species of this genus have been reported elsewhere. Apparently it is not a very severe disease as seen so far.

Winter injury. While occasionally this plant escapes the winter in protected places, our experience has been that it easily winter kills. This is especially true

of plants that run over the ground without a protective mulch. As there are many varieties some are perhaps more hardy than others, as is claimed for *H. helix* var. *baltica*.

Japanese Knotweed

False mosaic. Early in May, 1933, we saw this trouble, on the leaves of certain of the stems of *Polygonum cuspidatum* (*P. Sieboldi*), that appeared suddenly in a neighbor's yard where we had never seen it before. Some of the stems showed the injury while others did not and it was evident on the leaves that came out at a certain time and not on those of later development. The trouble was so similar in appearance to the yellow-green mottling of the true or infectious mosaic of certain plants that we have called it false mosaic: The angular spots were scattered rather abundantly on the leaves with their chlorophyll of a lighter green color than that of the normal tissues of the same leaf blades. There was a slight folding of the tissues, as was indicated by white lines usually above the veins. These white lines were evident where the epidermis had separated in folds from the adhering parenchymatous cells beneath. Evidently the trouble occurred when the young leaves were growing rapidly and the injury was confined to the rupturing of the epidermis and the slight injury to the young chlorophyll grains. Possibly later further injury to the tissues might result from these primary injuries.

The trouble was so similar to frost injury that we have seen on apple leaves that we have little doubt that this was the primary cause. Whether the injured spots had moisture on their surface or the water in the vessels was the secondary factor of the localized spots being injured by the cold we are not sure. There was no sign of insect injury and the trouble was certainly not due to an infectious virus since we were unable later to produce it on the young healthy leaves when the juice from the injured ones was applied to them. A similar trouble was seen on the leaves at the same time of the year on a butterflybush at Bridgeport in 1932.

Juniper

Leaf spot and Needle cast, *Cercospora Sequoiae Juniperi, Lophodermium juniperinum.* In June, 1927, at the golf course at Norfolk, the writer collected specimens of *Juniperus communis*, whose leaves were dying apparently from two fungi showing prominently on them, that turned out to be the above species. The first one, an imperfect fungus whose fruiting bodies showed as small, black dots on the leaves, looked more like a Phyllosticta than a Cercospora because the conidiophores were clustered in small, sclerotia-like masses. The second fungus, an Ascomycete, showed larger, black, elongated and raised fruiting bodies, split down the center, and was characteristic of the Lophodermium type. Both of these fungi have been associated more or less with injuries to the leaves of this host but which was the chief offender in the case and whether they had any relationship was not determined.

Nursery blight, *Phomopsis juniperovora.* Nursery blight has been discussed under Cedar, *q.v.*

Rust (stem), *Gymnosporangium clavariaeforme.* This is the perennial rust most commonly found on the wild juniper, *Juniperus communis*, that is sometimes used for ornamental planting in the state. The infected branches usually show a somewhat fusiform thickening and on this in the spring the yellow, jelly-like telia develop as evident, elongated columns that bear the III spores. The cluster cups of the I stage appear chiefly on the shadbush as the alternate host.

Rusts (foreign), *Gymnosporangium japonicum* (*G. Photiniae,*) *G. haraeanum* (*G. koreaense*). Both of these rusts were found originally on varieties of *Juniperus chinensis* imported from Japan. They occurred only in the III stage, the first species on the stems as conspicuous, flattened telia and the second as small roundish telia on the leaves. Neither of them escaped here, for their original infected hosts were largely destroyed before they were set out. There was little chance of the one or two infected specimens, later found in the nursery, escaping to the alternate hosts of the rose family on none of which was the I stage found. *See* Repts. 1912, 350 and 1914:15.

Kale

Bacterial black rot, *Bacterium campestre.* This host, *Brassica oleracea acephala*, is apparently not so commonly grown as formerly when this and the other diseases listed here were reported.

Bacterial leaf spot, *Bacterium maculicolum.* The bacterial leaf spot was found early (1902) on this host.

Clubroot, *Plasmodiophora Brassicae.* While not so commonly found here on kale, this host is probably just as susceptible to the clubroot. *See* Broccoli.

Kerria

Leaf-twig blight, *Cylindrosporium Kerriae.* This trouble of *Kerria japonica* was first called to our attention in a nursery in 1920 and we have since seen it there and in private plantings. The leaves show small, roundish to angular, light to reddish-brown spots with a distinct, darker border. If abundant they cause the leaves to turn yellow and die prematurely. Similar but more distinct spots show on the young stems and these may sometimes run together into extended cankers. In such cases the twigs are gradually killed and the leaves wither and dry up. In these twig-infected spots, the bark at the center in time may slit or crack away revealing the blackish, fruiting bodies at the center. From these ooze out the long, usually curved, white spores with or without evidence of a septum or two. This imperfect fruiting stage also appears in the leaf spots. Stewart, who described the fungus, found the asco stage, *Coccomyces Kerriae,* matured on the old dead leaves in the spring.

This is another disease where it will pay to cut out the diseased sprouts, rake up the dead leaves and, if necessary, spray the plants the next spring and early summer with Bordeaux.

Kohlrabi

Clubroot, *Plasmodiophora Brassicae.* Clubroot has been reported only once on this host, known technically as *Brassica oleracea caulo-rapa. See* Broccoli.

Kudzu Bean

Bacterial spot, *Bacterium medicaginis* var. *phaseolicola* (*B. Puerariae*). This is another bacterial disease that we collected before it was described on this host, *Pueraria thunbergiana.* The writer found it in 1924 in a flower garden at Fairfield where the vine was used as a covering on a trellis and although the disease was collected several times that year between the last of August and the first of October it has not been seen since there or elsewhere on this host. Our specimens all show small, reddish-brown, angular spots on the leaves that are more or less abundant. Usually there is a large, very distinct yellow halo around the invaded tissues, such as is shown in the wildfire of tobacco. As these vines were near some string beans which had apparently the same disease on them, the trouble evidently spread from the bean to the Kudzu vine.

Laceflower

Stem rot, *Fusarium* sp. We found the blue laceflower, *Trachymene* (*Didiscus*) *caerulea*, injured by this common basal rot both in a greenhouse and a private garden in 1932. *See* Aster.

Larch

Rust (leaf), *Caeoma* sp. The rust has been found here on the leaves of the native tree of *Larix laricina*, but not yet on it in cultivation. We have occasionally found, in the early season, a [illegible] sori [illegible] rust showing as small, round, dusty, [illegible] outbreaks of spores of the I stage but without evident peridia or cups. This stage without doubt connects with a Melampsora-like stage on some alternate

host of which there are several in the same general region in the northweste part of the state where it has been found.

Twig saprophyte, *Dasyscypha calycina.* This saprophyte, scarcely distinguishe from the parasitic form, *D. Willkommii,* found formerly in New England causin cankers on the larch, has been seen in this state merely on dead twigs. It show saucer-like, white, fruiting bodies with a pinkish, smooth fruiting surfac above. These fruiting bodies open widely in wet weather but close together i the dry. The parasitic, canker-producing form should be looked for and notic given the Station botanist if found, although it has been exterminated whe originally found in Massachusetts.

Larkspur

Bacterial leaf spot, *Bacterium Delphinii.* The angular, purple-black spot showing through on both sides, reach a diameter of about one-quarter of an inc and are few or numerous on the leaves of certain species of Delphinium. Som varieties or plants seem to be seriously injured while others near by may be prac tically free. This trouble should not be mistaken for the one, caused by mite which produces curled, swollen, purplish distortions on various parts of the plan If one finds the bacterial disease on the plants, he should gather and burn a the leaves and stems in the fall hoping to escape the trouble the next year. proves most troublesome in wet years and in moist, shady places.

Crown rot, *Sclerotium Delphinii.* This fungus rots off the plants at their ba just above and below the ground. Frequently the white mycelium can be se running over the ground from the rotted base and in this are developed, more less abundantly, round, reddish tubercules (sclerotia) about the diameter of a lar pin head. These are merely solid masses of mycelium that are white within t thin, reddish coat and serve to carry the fungus over unfavorable periods.

This fungus was first found by the writer in 1907 in a local nursery causi damage to several herbaceous plants. Later it was described elsewhere on o of these hosts, Delphinium, and given the specific name from this host. Howev the fungus attacks a great variety of plants besides this one, including cornflow Eupatorium, Funkia, Iris, Monkshood, Madonna lily, Penstemon, Physosteg Tulip, Valerian, Veronica and perhaps others. It is closely related to anoth species that has similar but smaller sclerotia, that attacks a variety of plants chie in the south, but which we have not yet seen here.

As the sclerotia are difficult to kill by any treatment, the gardener should gath up all of the decayed trash around the plants, removing any dead or injured stoc and also the dirt around the base of the plants so as to include all of these sclero New dirt from outside can be used to replace that removed. The bed should opened up where planted too thickly, so that the air and light can get in arou the base of the plants to favor drying out in wet weather. It might pay also spray the soil and base of the plants with Bordeaux several times in the spri and early summer. Once the trouble gets a start it may play havoc with a varie of plants but especially with the Delphinium in the wet seasons.

Leaf spot, *Ascochyta* (*Phyllosticta*) *Aquilegiae.* The only apparently fungo we have found on this host was seen in August, 1932, in a private flow garden in Orange where the lower leaves showed numerous, purplish-brown sp that apparently were caused by the imperfect fungus known as Ascochyta. Wh a fungus seems not to have been reported before on this host, we feel that spores are similar to *Ascochyta Aquilegiae* found in Europe and the United Stat on the related species of Aquilegia. This fungus was originally described as apparently because the septum is not always evident on certain of t spores on either host. The slight difference in the spots on the two hosts may due to the much thicker leaves of the Delphinium.

Powdery mildew, *Erysiphe Polygoni.* This has been seen often only in conidial stage and is not usually troublesome. In 1932, however, we receiv specimens in July where the perithecia developed rather abundantly on both stems and leaves, possibly after the specimens were kept in the laboratory for so time. *See* Clover.

Root rot, *Rhizoctonia Solani.* We have found the fungus rotting the roots o this plant. *See* Potato.

Fasciation. These curious, greatly flattened branches have been seen occasion a on this host. A specimen, collected in July, 1914, at Whitneyville, shows the flattening of a mature seed stalk. One of the best specimens we have ever seen on this or any other plant was sent us from Sharon in July, 1931. This shows the flattened flower stem at least four inches wide but of normal thickness before it divided near the top to produce the two flattened stems bearing the aggregate masses of blossoms. *See* Asparagus.

Frost injury. In May, 1932, we were called to see specimens of Larkspurs certain of which showed swollen, crinkled spots on the leaves or on the buds. The entomologists stated that the trouble was not due to mites which later cause somewhat similar spots on the flower parts. So the trouble was diagnosed as a frost injury, since frosts had occurred in that vicinity when the young plants were appearing.

Lawn Grasses

Brown spot, *Rhizoctonia Solani.* This is an old trouble caused by the soil fungus that causes injury to a great variety of hosts, especially seedlings and the fleshy parts of more mature plants. Many complaints have been made of it in yards, especially in newly seeded ones in damp weather, and in golf greens where heavy fertilization and frequent waterings have developed a luxuriant growth. Often it can be told by the white, mold-like growth of the mycelium that develops on the ground and rots the base of the grass stems into a definite, roundish, brown spot in the lawn.

It seems to develop in the more acid soils. Spraying with Bordeaux or com mercial forms of organic mercury compounds are said to prevent or lessen injury if started in time. *See* Spinach.

Lawn rot, *Helminthosporium-Pleospora* sp. Another trouble has recently ap peared, apparently caused by an entirely distinct fungus. This has an imperfect stage, known as Helminthosporium, that appears to be the parasitic form and a Pleospora or asco stage that seems to be the saprophyte since it becomes abundant on the old, dead grass. According to Stoddard, unlike the brown spot, it usually kills the grass in less definite spots but in a more widespread, general decay of the water-soaked tissues, often blackish when wet and grayish when dried out. This trouble seems to be most common in lawns and golf courses where the newer species of bent grasses, or mixtures of these with other species, are used. It is thought by Stoddard to be even worse than the preceding one but needs to be further studied as to its exact nature. The control treatment is the same as for the preceding.

Slime molds, *Physarum cinereum, Fuligo ovata.* These are two slime molds belonging to the Myxomycetes, or animal-like plants just below the fungi and bacteria, that appear on lawns suddenly after wet weather. By means of their motile, protoplasmic, microscopic cells they aggregate in masses over the tops of the grass to form a colored, jelly-like substance that soon changes in dry weather to their dusty, fruiting stage. *In the former and more frequently observed* this consists of numerous, small, grayish, separate pustules on the individual leaves that rupture slowly to disclose the colored spores. In the second species it is a large, conspicuous mass over the grass that is covered with a whitish, powdery coating that readily wears away revealing the dark-colored spores beneath. Neither of these slime molds are parasites on the living grass but only cause injury, if any, by smothering the leaves by these coatings.

Toadstools and Shelf fungi. *See* Addenda for a very general treatment of some of these fungi found in lawns.

Drought, etc. Continued dry weather is likely to turn the grass brown. If very severe it may kill out the grass more or less completely but usually the where well established, revives after sufficient rains have fallen. The injury may be general or in spots where the soil is poorer for one reason or another. These poorer spots showing first may give the impression that it is the brown spot. Sometimes the lawns show a sun scorch type of injury, especially those recently made. Injury

also can occur, when the grass is mowed long and not removed, from smothering the grass in wet weather beneath the thick masses of cut leaves. Too early cutting of young grass just starting, especially in dry or hot weather, may also cause injury. Watering of lawns in dry times to be effective should be continued during the dry period and preferably in not too bright sunshine.

Leek

Black molds, *Macrosporium parasiticum, M. Porri.* Leeks, *Allium porrum*, are occasionally grown here but the only troubles we have seen on them are the above two fungi. The first is not very serious being seen usually on occasional plants. This shows a white streak, usually along the midrib, on which is situated the black, fruiting stage of the fungus which at most seems to be a weak parasite. By some this imperfect fungus is said to be connected with the Ascomycete *Pleospora herbarum.*

The second is apparently a true parasite and is found on more definite, elliptical, light-colored spots with less of the black, conidial growth on the same. Thaxter called it the larger Macrosporium because of its larger spores with an elongated projection, which to our mind indicates it as an Alternaria.

Neither of these molds have caused much damage in recent years to this host, so nothing is done for their control. *See* Onion.

Lettuce

Bacterial soft rot, *Bacillus carotovorus.* This soft rot of *Latuca sativa* has been seen in fields rather rich in humus following moist weather and sometimes it causes serious loss. The bacteria on the ground develop in the lower leaves, often at their edges, and may work up into the interior as a head rot at first hidden. *See* Iris.

Downy mildew, *Bremia Lactucae.* We have seen this trouble usually in the fields in the fall when little damage occurs. In greenhouses, if it gets a good start serious trouble may occur to that and succeeding crops. So far there has been little complaint of it here in this respect, however. The conidial stage may show as a scattered or dense, white to grayish growth of the fruiting threads on the leaves. These fruiting threads are easily told from the other downy mildews by their hand-shaped endings with short, pointed tips bearing the spores. The mature spores for carrying the fungus over the winter are as usual produced in the interior of the tissues. If this disease gets a good start in a greenhouse used only for lettuce, it may prove so troublesome that special precautions have to be taken.

Drop rot, *Sclerotinia sclerotiorum.* The "drop rot" was so named on lettuce because the sterile, white mycelium of the fungus, creeping over the ground around the plants, would after entrance gradually rot off the lower leaves and cause them to drop over on the ground. The trouble sometimes becomes so bad in greenhouses where lettuce is continuously grown that it cannot be raised profitably. While never so bad as in some other states, we have seen it causing serious loss to lettuce and parsley under such conditions. Not only these two hosts are injured but we have found it also on cabbage and carrot in storage and on tobacco, goldenglow and Zinnia in seedbeds and gardens. The mycelium, especially in connection with the rotting tissues, develops small, flattened, but variable as to shape, black sclerotia that carry the fungus over long periods in the ground. On these after winter freezing, the asco stage may develop as elongated, funnel to cup-shaped at the top fruiting bodies that discharge their spores from their upper surface when touched. There is apparently no known imperfect spore stage. (Fig. 37.)

It is hard to control this fungus when it gets a good start because of the difficulty in killing these sclerotial bodies. If bad in the seedbeds these should be changed if this is easily done. In flower gardens the healthy plants of the susceptible host may be changed to a new locality, taking no dirt with them. In greenhouses or hot beds, if desired, the soil can be sterilized by high pressure steam or formaldehyde. The latter requires at least a 2% (1 to 50) solution and it is applied at the rate of at least two quarts to each square foot of surface. Before sterilization all of the old plant-rubbish should be removed and after the sterilization the soil should be covered for one or two days to keep in the fumes. Crops should not be planted on the same before two weeks.

Gray mold, *Botrytis cinerea.* Gray mold is seen occasionally, especially in greenhouses, but is not serious. *See* Geranium.

Leaf spot, *Septoria Lactucae.* This has been found occasionally both in greenhouses and out of doors. It has never proved serious here. The injury shows in the leaves as more or less irregular, grayish to reddish-brown spots or areas with the rather evident, imperfect fruiting stage as black, embedded dots in the same. There is no asco stage as yet reported but the fungus is said to carry over in the seed. In the greenhouse it may pay to pick and destroy the infected and dead leaves and use care in watering.

Rot, *Rhizoctonia Solani.* We have seen this in the fields, with similar conditions to those which caused the bacterial soft rot but probably with a more acid soil, where the lower leaves in contact with the ground were rotted and allowed the fungus to enter the head causing a more or less hidden, reddish rot of the interior. *See* Potato. It also causes damping off of seedlings. *See* Spinach.

Seedling rots, *Pythium debaryanum*, etc. This is the common cause of seedling rot in beds and flats although the spiny species of Pythium has also been found on dying seedlings. *See* Spinach.

Mosaic. This has been found occasionally on the Cos or Romaine lettuce but never very abundant. *See* Cucumber.

Prematuring, etc. It is difficult to grow lettuce even of the best varieties in the fields in summer because of its tendency to go to seed prematurely. With ordinary or wet weather followed by very dry periods, this is especially true. In our opinion lack of moisture is the primary influence and because of this the diminished supply of available nitrogen going into the plant for continued growth may more directly bring about the prematuring. If this is true then watering and nitrogen fertilization, where necessary, should prove helpful if carried out in time. Somewhat similar troubles, but usually not so common, are reported here on beets, cabbage, onions and potatoes.

Another effect of sudden, hot weather may show as a brownish searing of the leaves for a short distance inward, known as leaf scorch.

White heart. This is an obscure but apparently a physiological trouble complained of by growers of Big Boston and perhaps other varieties of head lettuce. The heads do not fill up solidly, the interior being composed of loosely rolled, hard, white, irregular leaves. Whether it is the result of irregularities of heat, moisture or due to certain soil conditions has not been determined.

Lilac

Anthracnose, *Glocosporium Syringae.* This fungous disease was sent to the Station in June, 1933, from Westport by a lady who wrote: "The twig is from a lilac shoot. Whatever it is that is attacking, it goes only for the young tender end of the shoots." We determined the trouble as the above fungus. This was the first time we had seen it and, so far as we know, it has not been reported before from the United States. The specimen sent was confined to the edge of the leaves which were curled and showed the small pustules of the fruiting stage. Later, on visiting the place we found the trouble chiefly on the young shoots at the base of the plants. The younger, upper leaves of these wilted, blackened and then dried up. The young shoots also were sometimes killed for a short distance and developed fruiting bodies. The spores resembled very much those of the bitter rot fungus.

The only reference to a trouble of this kind we have found is that describing the species from South Bavaria by Allescher and published in 1895 (Hedw. **34:** 276). His description fits our specimen well though the spores we saw were chiefly of the larger size, 12–18μ by 4–6μ. They were mostly rounded at the tips and were borne on compacted conidiophores embedded in the tissues. The fruiting stage shows as more or less evident, flesh-colored, embedded pustules. Allescher & Schnable also issued specimens in Fungi bavarici no. *478* but our speci-

mens in their exsiccati, while showing the dead and recurved edges of the leaves, do not show definite fruiting pustules and the spores seem to be the small size, around 6μ as described by the author, rather than the large spores that reach 18μ as also mentioned by him.

Apparently this fungus is not usually very serious, attacking the younger growth and often confined to the edges of the leaves. If, however, it does become harmful it would be well to spray the developing leaves, until full-size, two or three times with Bordeaux mixture.

Bacterial blight, *Bacterium Syringae?* This truble, somewhat questionable as to cause, is described in the Addenda.

Binder fungus, *Hymenochaete agglutinans.* The leathery growth of this Basidiomycete is occasionally seen binding together living or dead twigs in the woods. Specimens were once sent to us where it had bound together living twigs of the lilac, causing the death of the parts above through strangulation.

Gray mold, *Botrytis cinerea.* The gray mold occurs occasionally in wet weather of the spring on young leaves and stems. *See* Geranium.

Powdery mildew, *Microsphaera Alni.* This is one of our common powdery mildews occurring on a variety of plants but chiefly on shrubs and trees. The conidia and mycelium show in the summer on the leaves as an evident, more or less abundant, white growth. Usually the mature fruiting stage, known as perithecia, become apparent toward the end of the season as small, reddish and then blackish, spherical bodies embedded in this mycelium. It is the common fungous trouble of the lilac, chiefly on *Syringa vulgaris*, showing each season though the amount varies according to the favorable or unfavorable weather. Other hosts given here are: azalea, honeysuckle, oaks and sycamore.

Spraying, if thought advisable, and if taken in time, should control the trouble.

Graft blight. Recently there has come to the attention of the nursery inspectors, a common trouble of the lilac due to the grafting of the scions on uncongenial root stocks, chiefly privet. Some plants develop a more or less sickly, yellowish growth of canes and leaves as compared with those grafted on their own kind of roots. Such plants are often sold while in fair condition but gradually go back without evidence as to the real cause of the trouble.

Lily

Crown rot, *Sclerotium Delphinii.* Crown rot has been found on the Plantain lily (Hosta) and the Madonna lily (*Lilium candidum*). *See* Larkspur.

Drop rot, *Sclerotinia sclerotiorum.* This was reported once on the Bermuda Easter lily, *L. longiflorum* var. *eximium*. *See* Lettuce.

Gray molds, *Botrytis* sps. *See* Addenda.

Rhizoctonia rot, *Rhizoctonia Solani.* The Rhizoctonia rot was seen once on the goldband lily (*L. auratum*) and the Madonna lily, rotting the roots badly. *See* Potato.

Mosaic? One of the common troubles of Easter lilies seems to be mosaic showing in a mottling of the leaves and resulting in a poor growth of the plant and their blossoms. It was first noticed years ago on the Bermuda Easter lilies shipped to this country. While we have not had much experience with this particular mosaic trouble, we have recently seen a case where it was bad on certain Japanese Easter lilies. One grower complained that a very large percentage of the plants he grew from these bulbs. (*L. longiflorum* variety *Eraku*) were so poor that he could not offer them for sale. While lice were very evident on these when seen by us, he claimed that they came on chiefly after he neglected the plants because of their poor condition. So far as we could find, the mosaic mottling of the leaves showing as somewhat elongated, lighter green areas in the normal green, was the apparent cause of the poor condition of the plants. We did not determine if the trouble was contagious, either by the lice or the use of needle punctures, but it appeared to us to be a possible virus mosaic.

In this case it was probably carried by the bulbs but the presence of the lice on the plants was a possible means of spreading it further. The use of perfectly

healthy bulbs and the control of the lice would be the means of combatting the trouble.

Split blossoms. A trouble of easter lilies recently complained of to the writer was the splitting apart of the petals of the flowers when they came into full bloom, thus giving them an abnormal and poor appearance. This was caused by the petals at one or more places separating, giving the scraggly appearance. Normally these petals, though they are divided down to the top of the ovary, still adhere together by their edges into a united blossom. Such split blossoms are of little value for sale.

We are not sure of the cause of this trouble but it may have resulted from the manner in which they were forced to appear at just the right time for Easter.

Lily of the Valley

Leaf spot, *Undetermined.* The only trouble we have found on *Convallaria majalis* is a leaf spot, apparently caused by some fungus, though as yet we have never found its fruiting stage on the spots and so cannot be sure of its nature or identity. Several troubles have been found elsewhere and some of them are on the leaves but we have been unable to identify them with the purplish, elliptical spots, whose centers sometimes become brownish, that we have seen more or less abundantly on this plant especially in the late summer and the fall. We have a suspicion that the fruiting stage does not begin to mature until the following spring on the old, dead leaves.

Linden

Anthracnose, *Gloeosporium Tiliae.* While this has not yet been reported on Tilia from this state but was sent for determination from Long Island, it should be looked for here. It forms small, round, light-brown spots with darker borders but, where running together or at the edges of the leaves, it may become more irregular in shape. In transmitted light the embedded, reddish, fruiting pustules can be seen when matured. No other stage has yet come to light. Small cankers at the base of the petioles sometimes cause defoliation and the smaller branches are also infected and so carry the fungus over the winter.

One or two sprayings on the growing leaves with perhaps one later should control the trouble. If feasible cut off the infected twigs.

Black mold, *Fumago vagans.* This trouble has been seen a number of times and was reported from a city park as prominent on the trees there. The imperfect fungus shows as a black growth of mycelium covering the surface of the leaves and evidently gets its start following lice injury as it is not a parasite but develops in the honey dew of the latter. Between the lice injury and the shading of the leaves by the fungous coating, the leaves may drop prematurely but even if they do not their appearance is greatly marred. Control the lice.

Locust

Leaf spots and wood rots. Both the black and honey locust are found here, but as yet no parasitic fungi have been reported on them. These fungi, elsewhere, are chiefly leaf spots and parasitic or saprophytic wood-rots of various kinds and no doubt some of them occur here. We have seen one or two of the latter on dead limbs of *Robinia Pseudo-acacia*.

Lupine

Powdery mildew, *Erysiphe Polygoni.* We found this mildew once very abundant on wild specimens of *Lupinus perennis* and since this is occasionally grown in flower gardens it may appear there. The leaves were abundantly coated with the white mycelium and conidia and the perithecia were also numerous and conspicuous. *See* Clover.

Rhizoctonia rot, *Rhizoctonia Solani.* The only trouble we have seen on cultivated Lupinus was a root rot sent us by a nursery company in 1932. The sole fun-

gus we could find on the roots of the plants was the above species. This may not have been entirely responsible, since Dr. McCormick found some signs of insect work, and there has been another soil fungus that has been reported elsewhere causing damage. *See* Potato.

Mangel

Crown gall, *Bacterium tumefaciens.* Mangel is merely a variety of beet called *Beta vulgaris macrorhiza* and so has practically the same troubles. The crown gall has been seen once as a conspicuous gall at the top of the roots. *See* Rose.

Leaf spot, *Cercospora beticola.* The leaf spot is commonly found on this host and occasionally is rather prominent. *See* Chard. (Fig. 38.)

Root rot, *Pythium debaryanum?* This has been seen by the writer but once in a mangel field after the roots were dug but the injury was noticed earlier by the grower through the wilting and yellowing of the leaves. The injury came because of a serious rot of the tap roots, apparently starting in small, side roots in the ground and working into the tap root, always below and rarely reaching into the crown. The rot was favored by the wet summer and low ground of most of the field. While the mycelium seen in the edge of the infected tissues was of the type of the above fungus no spores were found in the infected plants, so there was the possibility that it may have been a related fungus that has been reported elsewhere on this host.

Once a field shows this trouble, it should not be planted with a similar root crop for some years.

Scab, *Actinomyces scabies.* Sturgis in 1896 reported as high as 40 per cent of scab on mangels planted in infected soil. *See* Potato.

FIGURE 37. Lettuce drop rot.

FIGURE 38. Mangel leaf spot.

FIGURE 39. Maple leaf scorch.

Maple

Anthracnose, *Gloeosporium saccharinum.* We have collected specimens of injuries caused by Gloeosporium on the leaves of Sugar (*Acer saccharum*), Norway (*A. platanoides*), and Japanese (*A. japonicum*) maples. The general appearance of the spores is about the same, though the type of injury to the leaves may vary somewhat with the different hosts. A number of species of Gloeosporium have been described on the various maple hosts, but until we have reason to believe they are distinct we shall consider them as one, as indicated by the above name.

The common type, most often found in the hard maple, is the irregular, greenish-brown but finally reddish-brown, dead area reaching from the leaf margins inward, often following the ribs, and isolated smaller spots within the green tissues. On the Norway maple we have seen specimens where the injury was confined to long, narrow lines on either side of the midrib or larger veins. On Japanese maples the injury is often in smaller spots or irregular specks scattered in the leaf tissues. Frequently it is difficult to find the small, embedded, fruiting bodies of this imperfect fungus. When this is the case and the injury is largely confined to the margins of the leaves, it is hard to distinguish anthracnose from sun scorch.

Apparently the asco stage has not been found on the old infected maple leaves, but it is just as well to burn these in the fall. While not usually serious, except in wet springs or early summers, spraying as for the similar sycamore anthracnose should prove effective.

Canker, *Tuberculariа vulgaris.* This imperfect stage of *Nectria cinnabarina* has been found on the dead twigs of the Japanese maple, *Acer palmatum,* probably following other injury. *See* Elm.

Heartwood rots, *Fomes applanatus,* etc. Our impression is that the Fomes fungus is the chief heartwood rot of our maple shade trees. However, the fruiting stage of this our largest woody, poroid, shelf fungus belonging to the Basidiomycetes, is not always present to identify it as the cause. Other fruiting fungi that have been found on living maples and which may be responsible at times for this or sapwood rots, are *Fomes connatus, Hydnum septentrionalis, Pleurotus ostreatus, P. sapidus* and *Polyporus squamosus.*

For treatment at least clean out all the dead wood, allow complete water drainage and cut back the bark properly to facilitate new cambium on all the sides.

Leaf spot, *Phyllosticta minima.* Leaf spot of maples, while usually less serious than the anthracnose, is more common especially on nursery and forest trees. As with the former fungus more than one species has been reported on the same and different hosts but those found here are included under one species until more definite information concerning their difference is shown. The spots are small, usually about one quarter of an inch in diameter, light to reddish-brown, often when mature with a lighter center and a darker border. They show the small, black, fruiting pustules most prominently, when present, on the upper surface. No other than this imperfect fruiting stage is known. The fungus has been found on the box elder (*Acer Negundo*), red (*A. rubrum*), soft (*A. dasycarpum*), hard, sycamore (*A. pseudoplatanus*) and Norway maples.

No spray treatment is usually necessary; it can do no harm to rake and burn the old leaves.

Powdery mildew, *Uncinula circinata.* The conidial and mycelial development on the surfaces of the leaves may show as a scattered or a more dense, white growth. The perithecia are more conspicuous and larger than others of these "hooked" species and are found chiefly on the under side of the leaves, often without much evidence of the mycelium.

No special treatment is necessary, though it may help to burn the old leaves.

Tar spot, *Rhytisma acerinum.* This Ascomycete is easily distinguished on the leaves where it produces one to several, tar-black blisters, like finger prints, on the upper surface but which beneath are cupped and less marked in color. It is abundant on soft, especially the cut-leaf variety, and red maples. It is found also in the woods where another similar species with less evident spots likewise occurs. The fungus produces an inconspicuous but questionable spore stage on these blisters but it is only after the leaves fall and pass the winter that the true asco spores mature.

The usual preventive treatment is to rake and burn the leaves in the fall.

White mold wilt, *Cristulariella depraedans.* So far this newly discovered trouble has been confined to the woods where small shaded trees, under variable moist and hot weather conditions, have developed it. The leaves first develop grayish areas or spots as if from a scorch but later may change color and drop off. The inconspicuous, fruiting stage of this imperfect fungus may show as a few, white heads, the size of a small pin head, on the under side of the leaves especially on the veins.

Wilt, *Verticillium alboatrum?* There seems to be some doubt as to just what species causes the wilt of the maple. In this country it is referred to as Verticillium sp., while in Europe it is designated specifically as given here. We have found the injury here chiefly on Norway maples. These show the trouble by dropping the withered, green leaves and then the branch bearing them may die and this may be followed by the gradual death of the whole tree. No fruiting stage shows on these since the trouble comes from a fungus whose mycelium

and spores are borne internally in the woody tissues. The injury there cuts off the water supply with resulting dropping of leaves and death of the branches. Some believe, however; it is the toxins, developed by the action of the fungus, that is the cause of the death of the leaves when they reach them, rather than the cutting off of the water supply. It can be detected by cutting across the small stems, when its presence is indicated by the dark-green areas in the sap wood. *See* Barberry and Raspberry.

We have seen several adjacent trees where the trouble seemed to spread from the first affected though unfavorable soil or other conditions may have had their influence. We have also known of trees where a single branch only became affected. In any case it is well to prune off all infected branches and cut down severely injured trees and burn all the rubbish.

Fasciation. In 1932 a tree man showed us a specimen of red maple where the one year's growth showed a flattening about two feet long which was an inch wide but only a quarter of an inch thick, with the divided, elongated flattened ends somewhat curved. *See* Asparagus.

Knots and Bunched sprouts. These are not uncommon on street trees that in some way have been injured, often probably by local winter injury in the bark chiefly on the main trunks. The injury has stimulated unusual growth in abnormal ways, usually inducing bud formation, that continues year after year so that there remain these large gall-like growths or closely clustered, small twigs that may increase in number but where none gain ascendance over the others.

Leaf scorch. This trouble particularly on hard maples may suddenly occur when moist or wet weather, especially in the spring, is quickly followed by bright sunshine or it may result from severe dry weather, certainly where there is root injury to the trees. Whipping winds when the leaves are young may add to the injury. The leaves turn reddish-brown in irregular areas from the margins inward. Such injury is often difficult to tell from spray, smoke or gas injury and even in some cases from the anthracnose trouble, unless the investigator knows of the probable cause. In occasional years the trouble is so general that some people have become alarmed for fear some new disease is at work. On the injured leaves which usually adhere to the trees, certain saprophytic fungi in wet weather may appear which to those uninformed might be considered the real cause. It is usually difficult to determine in old shade trees why one or more show the trouble when others nearby remain normal, but perhaps the secret lies buried in the roots or soil. (Fig. 39.)

Transplanted trees should have good fertilization and plenty of water under a mulch covering to insure rapid new growth to supplant the mutilated roots. In very dry periods occasional heavy night watering of valuable trees might be advisable. Fertilization in some cases might also help.

Oil injury. This is apt to occur when certain miscible oils are used without care on dormant hard maples to kill definite, insect pests. The oil may penetrate the bark and kill the cambium in such cases.

Staghead. This is a general term we apply, chiefly to hard maples, where the large, central branches gradually die, often from causes not readily made out on careful examination. Girdling borers are sometimes the rather inconspicuous cause.

Decay of the wood of these dead branches always results, caused by fungi often with no evident, woody, fruiting bodies. Such branches should usually be removed before or after death and the cuts properly treated, but their removal is apt to result in a poorly shaped tree. Fertilization should stimulate new growth more quickly.

Steam roller burn. A common injury seen along the highways that are lined with trees, especially in cities, are the burned leaves due to the steam rollers used in fixing the pavements, etc. This injury is especially common on the maples whose branches just reach above the smoke stacks of these rollers. The heat from these kills the leaves, particularly where the rollers are under them for some time. Possibly also there is some injury from the coal smoke when the leaves are wet. Usually the injury is a temporary one limited to the death of the leaves but sometimes the branches are also injured or killed.

There should be more care used by the owners and attendants of these rollers that this injury be limited to the least possible amount.

Mignonette

Leaf spot, *Cercospora Resedae.* In greenhouses and gardens this trouble of *Reseda odorata* occasionally appears on the leaves as numerous, small, light-brown spots, sometimes with a slightly darker border. When in fruiting condition these spots are often covered with a dense growth of the fruiting threads and their lighter-colored spores. No asco stage of this imperfect fungus has yet been reported.

If suspicious of the trouble, start spraying the plants, when young, with Bordeaux.

Rhizoctonia rot, *Rhizoctonia Solani.* This fungus is rarely found in greenhouses, rotting the roots. *See* Potato.

Millet

Smuts, *Ustilago Crameri,* etc. While this smut sometimes causes considerable injury where Hungarian millet, *Setaria italica,* is commonly grown, we have seen it here only a few times and then in only small amounts. The spikes are changed into black, smutty masses by individual infection of the interior of the separate spikelets.

This smut can be controlled by seed treatment if desired.

On the Japanese millet, *Echinochloa frumentacea* (*E. Crus-galli edulis*), two entirely different smuts (*Ustilago Crus-galli* and *Tolyposporium bullatum*) are also found here but these are of even less importance.

Mockorange

Crown gall, *Bacterium tumefaciens.* Crown gall has been reported once on Philadelphus sps. in a nursery. *See* Rose.

Gray mold, *Botrytis cinerea.* On this host the gray mold has been seen rarely on young leaves and twigs in wet weather of spring. *See* Geranium.

Monkshood

Crown rot, *Sclerotium Delphinii.* Crown rot is not uncommon on Aconitum species under conditions described under Larkspur, *q.v.*

Rhizoctonia rot, *Rhizoctonia Solani.* The rot was found once on the roots of this plant. *See* Potato.

Mountain Ash

Crown gall, *Bacterium tumefaciens.* This trouble has been seen only rarely in nursery inspection on the above host. *See* Rose.

Fire blight, *Bacillus amylovorus.* While this is a known host and has been reported here once or twice, a more critical examination of specimens as to the cause is needed. *See* Pear.

Rust (leaf), *Roestelia globosa.* This rust has been found rarely in the northwestern part of the state; however, it may become prominent there on individual trees. It is claimed by some that the leaf rust on Mountain Ash, *Sorbus americana,* in northern New England and Canada is a different species, *Roestelia cornuta,* from that found in southern New England, hence we have placed our specimens with the latter species, known as *R. globosa.*

Looking at specimens collected in both regions the chief differences we note are that the northern ones have shorter, stouter, more pointed and permanent peridia on larger, thicker spots. In these respects our few specimens from Connecticut show peridia more like those on Crataegus, the common host here for *R. globosa.* The available host of the III stage of *R. cornuta* in the north is

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only the juniper while here both juniper and red cedar are available but the III stages on these are usually quite distinct. Further infection work with these III stages on mountain ash is needed. *See* Hawthorn.

Mountain Laurel

Leaf spots, *Cercospora Kalmiae, Phyllosticta kalmicola, Septoria kalmicola, Mycosphaerella colorata.* All three of these imperfect fungi and the last or sac fungus have been found on the leaves of the mountain laurel, *Kalmia latifolia,* both wild and cultivated, but, since the spots they produce are apparently so similar and often lack a fruiting stage, we merely give here a general description covering all of them. The spots are small, about one-quarter of an inch in diameter, round, at first purplish, but finally white, gray or brown in the center but always with an evident purplish border of variable width. Sometimes these spots are so abundant that they kill the tissues between them and at the same time greatly mar the appearance of the infected plants.

As the leaves carry over the winter on the bushes, the spots show at all times of the year. It may be that one of these imperfect fungi may be connected with some asco stage, as the one already found on the leaves, but detailed study is needed to bring out all the facts.

In the late spring and early summer of 1932 we found the Ascomycete given here had matured and was common. Many complaints had been received the previous six months of this spot disease. It seems to us that this Ascomycete is largely responsible for most of these leaf spots. The badly infected leaves were often shed in the early summer but new infections on the young leaves apparently take place from these and those still remaining on the shrubs, under favorable weather conditions.

As this is the state flower and is frequently grown in cultivation, information is sometimes asked for control of these leaf spots. While no very definite experiments have been tried by us, our judgment would be that spraying with Bordeaux with a potassium-oleate sticker would prove helpful but might require time to get rid of the badly infected leaves that act as sources of infection. We would suggest three sprayings beginning on the young leaves in the spring and continuing up to the blossom period, with perhaps one afterward. These treatments should be repeated each year until the trouble becomes inconspicuous. The potassium-oleate Bordeaux stuck to the leaves a long time for us where we used it on these plants. One should also rake up and burn the old leaves after they fall in the spring.

Scorch. This trouble shows a reddish-brown, dead area reaching from the edges of the leaf inward. Sometimes the trouble is due to winter injury since the leaves adhere to the bushes throughout the year or longer. At other times it may come as a sun scorch on plants in the open or those subjected to hot sunshine from one direction, while protected on the other sides by buildings.

We believe in a soil mulch to hold water in the ground in summer and to protect the roots in winter. This also should favor an acid condition of the soil that these plants seem to need. If necessary water the plants through the mulch in summer, and in winter give extra protection to the parts above ground.

Mulberry

Bacterial spot, *Bacterium Mori.* This is the only disease we have found on this host, *Morus alba* or *rubra,* and then just once in a nursery. It makes small, irregular, reddish-brown spots on the leaves which have a pellucid appearance when wet. On the young twigs it shows as small cankers that may run together and gradually girdle the same, producing a stunted growth of the twigs and sickly, yellowish leaves, or it may gradually heal over showing as a rough swelling on the bark.

The trouble in this state is so unusual that merely cutting out the infected twigs, raking together the leaves and burning both, should ordinarily take care of the trouble without spraying.

Muskmelon

Anthracnose, *Colletotrichum lagenarium.* Anthracnose appears occasionally on both leaves and melons of *Cucumis melo* but not as bad as on watermelons, *q.v.*

Bacterial angular spot, *Bacterium lachrymans.* This bacterial spot has rarely been seen on the leaves. *See* Cucumber.

Bacterial soft rot, *Bacillus carotovorus.* We have seen this only occasionally as troublesome on melons. While a similar disease of the fruit has been described elsewhere as *B. melonis,* it does not seem that the trouble is distinct from the ordinary soft rot. *See* Iris.

Bacterial wilt, *Bacillus trachciphilus.* This bacterial wilt in certain seasons is troublesome but not so bad as on squash, *q.v.*

Black mold blight, *Macrosporium cucumerinum.* Years ago this trouble was called to the attention of the public by Sturgis of this Station and identified as *Alternaria Brassicae* var. *nigrescens.* It is an Alternaria rather than a Macrosporium and the spores approach those of *A. Brassicae.* We have found it occasionally during the past thirty years but more frequently earlier than recently. It can cause considerable damage but usually not so great or as often as does the downy mildew on this same host. The spots on the leaves, where the damage is done, are quite similar for the two. With this one conspicuous, round, reddish-brown spots may show some indications of concentric rings of growth and a very limited amount of the black fruiting threads and spores. No other stage is known. It also occurs less frequently on the watermelon.

The treatment should be the same as for the downy mildew.

Downy mildew, *Peronoplasmopara cubensis.* This is the disease that fifteen to thirty years ago nearly ruined the muskmelon industry in the state. While not so common in recent years, it still is the chief pest with which melon growers have to deal in spraying. It attacks all of the varieties grown and is about as bad on the cucumber, both garden and greenhouse varieties, on which it usually gets an earlier start. It also occurs less prominently and plentifully here on squash, pumpkin, bottlegourd and watermelons. This fungus has been found only on the leaves where it produces usually conspicuous, round or somewhat angular spots, varying from light to reddish-brown according to their age and the host infected. When the disease is abundant, these leaves wither up and the vines often die before they mature their melons. Even melons that do mature on such vines are usually of very poor quality as to taste.

The fungus develops a rather scanty growth, on the under side of the spots, of its tree-like, white conidiophores bearing the large conidial spores at their tips. These spores are purplish in color and give this tint to the infected spots, especially at the edges when wet weather favors their abundant production. Just how the fungus passes the winter here is not surely known as search has failed to reveal the oospores of the mature stage. Of course, in some cases, it might hold over in greenhouses in its conidial stage but its presence there is infrequent. Presumably it advances here gradually from infected plants grown in the south, which may account for its variable appearance. However, the oospores have been found recently more or less abundantly in the leaves, especially the upper leaves, in Japan by Hiura and Kawada (Jap. Journ. Bot. 6:507–513. *Illust.* 20 D. 1933). This means that a further search should be made for them in Connecticut. (Fig. 40.)

The mildew, on both the melon and cucumber, is usually controlled by spraying with Bordeaux; but the treatments should start on the vines when they first begin to run and be continued up to the end of the season. This requires treatments from one to two weeks according to the weather conditions.

Powdery mildew, *Erysiphe cichoracearum.* This other but very different mildew is occasionally seen in its conidial stage on the leaves in late summer and causes no particular harm. *See* Phlox.

Scab, *Cladosporium cucumerinum.* The scab trouble is conspicuous only on the fruit where it shows in wet weather as small, sunken areas with the dense, olive-green, fruiting threads. *See* Cucumber.

Seedling rot, *Pythium debaryanum.* It is found rarely. *See* Spinach.

Bordeaux injury. Sometimes in bright, hot weather the leaves of this plant will show a whitish or yellowish area at their margins merging into the normal green color. Similar but more pronounced injury frequently shows on vines sprayed with Bordeaux and may hinder the vigorous growth of the same. When this is

likely to occur we suggest that the spraying be confined to the cooler and less bright days or made only in the late afternoon. Some try to reduce this trouble, without much success, by the use of a weaker Bordeaux or a reduced amount of copper sulphate.

Growth cracks. The melons sometimes show this trouble when dry weather is followed by a favorable, wet period developing a rapid growth of the melons with a resulting cracking in the rinds especially at the blossom end. Different varieties vary considerably. *See* Snapdragon.

Mosaic. This virus disease is seen occasionally but is not nearly as bad as on the cucumber, *q.v.*

Mustard

Clubroot, *Plasmodiophora Brassicae.* Apparently little mustard (Brassica sps.) is grown in the state. Occasionally it is grown for seed purposes and sometimes the Italian farmers plant it for greens. So far we have seen only two troubles on mustard, the species of which we have not determined, the first and chief one being this trouble on the roots as described under Broccoli, *q.v.*

Downy mildew, *Peronospora parasitica.* This is the second trouble, seen here in 1932, in a vegetable garden of greens where it was doing no especial harm. We have seen it more abundant, however, on wild mustard and charlock. *See* Turnip.

Narcissus

Bud blight. We have had complaints, especially of certain double varieties, that after they produce the blossom buds these fail to develop further, remaining enclosed in the spathes and finally dying. Our entomologists have found no insect responsible for this trouble. Competent observers claim it is not a frost injury. Our examination of the injured tissues has so far failed to reveal the mycelium of a fungus as a possible cause. In at least two cases that came to our attention, the plants showed this trouble only after they had been transplanted to another place. We have no explanation of the cause.

Running out. The failure of certain Narcissus species to blossom after growing a number of years in the same place is not an uncommon trouble. See Daffodil.

Oak

Anthracnose, *Glocosporium canadense.* This disease is considered by some as identical with the sycamore anthracnose and it has a similar effect on the oak hosts, although these belong to quite a distinct family from the former. The fungus carries over winter in its imperfect stage on the small twigs, but it is the young leaves in the opening buds or as they grow to maturity that suffer the greatest injury. We have not yet seen the asco stage. The oak most frequently and seriously injured here is the white *(Quercus alba)* but the fungus has been reported on the scarlet (*Q. coccinea*), swamp (*Q. palustris*), chestnut (*Q. Prinus*) and black (*Q. velutina*) oaks. *See* Sycamore.

Chestnut blight, *Endothia parasitica.* This fungus rarely occurs here as a weak parasite causing no harm on the white (*Q. alba*) and red (*Q. rubra*) oaks. A similar but entirely saprophytic species, *E. radicalis*, has been found on the red oak.

European canker, *Nectria galligena.* This has been collected on *Q. rubra* and *Q. velutina* in this State. *See* Birch.

Leaf curl, *Taphrina caerulescens.* This fungus forms large, somewhat thickened, whitish to brownish, eventually dead spots on the leaves. When fruiting there is a purplish tinge or bloom on the lower surface where the fungus is confined. In time the spots become cupped and wrinkled below. The trouble becomes noticeable in late spring or early summer and has been found here on *Quercus alba, Q. Prinus, Q. rubra* and *Q. velutina.* The last named is the most frequent host.

Spraying the trees just before the buds open and perhaps again on the new young leaves apparently should control the disease, since it is related to the peach curl where this treatment is effective.

Leaf spot, *Marssonina (Marssonia) Martini.* In 1914 this was reported once on *Quercus alba* from Pomfret. Probably it is not uncommon in the woods on this and other species of oaks. It forms a definite, circular, brownish spot with a narrow, purplish border and is *one-eighth to one-quarter* of an inch in diameter according to the species of oak on which it occurs. On the under side is the fruiting stage of this imperfect fungus which oozes a yellow globule containing the elongated, somewhat curved spores usually showing a septum at their center. This genus is closely related to Septogloeum under which it is placed by some authorities.

Powdery mildew, *Microsphaera Alni.* The mildew is not uncommon on the leaves, especially of sprout growth. *See* Lilac.

Rust (Pine-Oak), *Cronartium Quercus.* This fungus has been found here but once on the trees of an estate along the sea-shore. It was not serious in this case as only the III stage developed for some unexplained reason. The leaves had few to numerous infections but showed only inconspicuous yellow spots above while below were the reddish-brown, hair-like, telial columns of the III spores. The II stage when it does appear, shows before the III stage as more or less numerous, small, yellowish outbreaks on the under side of the leaves also. The disease was limited to the general vicinity of the small, infected, wild pines of *Pinus rigida* that earlier produced the I stage. Only leaves of the *Quercus velutina* and *Q. coccinea* were infected though *Q. alba* and *Q. Prinus* were equally exposed. *See* Pine.

Stem canker, *Strumella coryneoidea.* This trouble so far has been found only in the woods but according to some observers is a somewhat prominent one in certain situations. It shows as a large canker eating out the bark and outer layers of the wood. Usually only a single canker is found on a tree, generally above reach on the main trunk. The rotting wood at this spot so weakens the tree that it is often broken off there in severe storms. The fruiting stage that is said to cause this trouble is not very evident and sometimes cannot be found on the canker. It forms inconspicuous, fruiting pustules of the above imperfect fungus which to the writer seem hardly likely to cause a serious wood rot. At times it almost appears as if the trouble might be started as a winter or other injury opening the way for entrance of spores of some wood-rotting Basidiomycete. Wet locations favor the trouble apparently. So far it has been found here by the writer on *Quercus alba, Q. rubra, and Q. palustris*, with the last the most frequent host. An infected tree should be cut and used for fire wood.

Wood rots, *Polyporus sulphureus, Fomes igniarius.* These are the only two poroid fungi that we have found on the living oaks, though perhaps others, as *Fomes applanatus*, may be responsible for rot of the old wood as they have been found on the dead oaks or on their logs. The Polyporus is a conspicuous, at first fleshy and then corky or harder, fungus, usually with adhering and overlapping shelves that are orange-red above and sulphur-yellow on the porous, lower surface. We have found it apparently on injured trees where it may act only as a heartwood rot.

The Fomes seems to be a sapwood as well as a heartwood rot and is sometimes seen at a definitely injured spot on the trunk, showing as an evident, roundish, hard, reddish-brown, gall-like growth that may not develop a fruiting surface for some years. It has been found here also on apple, butternut and a few forest trees.

Remove the fruiting bodies when found, and protect the bark of infected branches but use judgment in cutting when the disease occurs on the main trunk.

Drought injury. *See* Addenda.

Woody galls. By this trouble we do not mean the small insect galls that sometimes occur abundantly on the oak trees, but the conspicuous, hard, woody galls on the larger branches, usually showing on a single tree in the neighborhood. These subspherical galls usually vary in size from that of a fist to that of a large head and have thick, rough bark and a solid, permanent, swollen growth of woody tissues that is abnormal in arrangement as compared with the rest of the branch. Similar but smaller and smoother bark galls occur on the hickory.

The galls result from some injury at these places but the cause is not definitely known since they are not supposed to be caused by the bacterial crown-gall organism to which they bear the most striking resemblance. They occur on shade and forest

trees but do not seem to spread, at least not easily, on the infected tree and apparently not at all to adjacent trees.

If desired the limbs showing these galls can be removed, cutting them some distance below for safety, but the galls do not usually seem greatly to injure the infected branches.

Oats

Leaf spot, *Helminthosporium Avenae.* Oats, *Avena sativa,* are our chief, small, grain crop but the fungi on oats, or any of the similar crops, do not cause as much injury as they do in the larger grain-districts further west. Therefore our farmers do not generally find it necessary or advisable to take advantage of certain treatments used elsewhere. This particular disease has never been bothersome here and is merely found in a minor way on the leaves as small spots with a more or less evident development of this imperfect fungus as a blackish growth on the surface. The asco stage is said to be *Pleospora Avenae.* No treatment is required here.

Rust, crown, *Puccinia coronata.* This is the common rust of oats and is also found on a few wild grasses in the state. The I, or cluster cup, stage has been found here only once on wild specimens of Buckthorn, *Rhamnus cathartica.* The II stage is conspicuous in midsummer on the leaf blades of the oats, forming small, oval to linear, dusty, orange outbreaks usually numerous between the veins. The III stage appears later as similar pustules but with the black spores more permanently covered by the epidermis and so lead colored. This rust is considered less injurious than the next though much more frequent here.

Rust, stem, *Puccinia graminis.* This rust occurs on the leaf sheaths and stems causing the grain to lodge when abundant. *See* Wheat. (Fig. 41).

Smuts, *Ustilago Avenae, U. levis.* These two smuts are about equally common in our grain fields. They are similar in that both change the panicles of grain into black, dusty outbreaks. The former, however, completely changes the individual spikelets into olive-black masses that gradually wear away entirely, while the latter does not so completely destroy the spikelets but only their inner and basal parts where the dusty masses are more of a purple-black color. These dusty outbreaks are composed entirely of one-celled spores which in the first species are slightly roughened but in the second are smooth.

Seed treatment by sprinkling or dusting with chemicals, usually formalin or copper carbonate, will prevent infection in the succeeding crop. Here, however, as the loss rarely runs to five percent of the grain and usually is only one or two percent or less, seed treatment is rarely given.

Yellow leaf. In dry years growing fields sometimes show a large number of yellowed leaves. This is without doubt due to lack of sufficient moisture since there is never any evidence of bacteria or fungi on them or their roots.

Okra

Bacterial spot, *Undetermined species.* This trouble has been seen only once in August, 1922, at a seed farm in Milford. We have been unable to identify it with any described bacterial disease on this host. Its appearance on the leaves was very striking often causing evident, angular spots in the tissues but more commonly showing as lines following the veins and their branches. It produced a reddish-black discoloration of the infected tissues with a more or less evident yellowing surrounding the same.

Powdery mildew, *Erysiphe cichoracearum.* On Okra, *Hibiscus esculentus,* this mildew is found occasionally as a mealy, white growth of the conidial stage only. *See* Phlox.

Wilt, *Fusarium vasinfectum.* We have occasionally seen this disease in garden plants as they reach maturity. The leaves become irregularly yellowed and then dry up and drop off from the stems. This takes place from the bottom of the plant upward. A cross section of the stems shows discoloration of the bundles and microscopic examination reveals the presence of the mycelium of this fungus. The water supply to the leaves is gradually cut off and this results in their death.

Care in selecting seedlings from uninfected seedbeds and planting in garden soil not previously infected are the chief precautionary measures.

Onion

Black molds, *Macrosporium parasiticum, M. Porri.* Two different species of Macrosporium have been found on the stems and leaves of onions, *Allium cepa,* in this state that differ much in the microscopic appearance of their spores. These were both described by Thaxter years ago. The first one (called by him *M. sarcinula* var. *parasiticum*) he found on onions, especially seed ones, often following injuries by the downy mildew as a semi-parasite. It made a dense, black growth of the roughish, small spores on short pedicels. *See* Leek.

The second one with longer, more elongated, smooth spores, evidently an Alternaria similar to those found on potato and cabbage, he considered more of a true parasite. Further study is needed on these two imperfect fungi and the possible injury they may cause; both are also found on the leek. *See* Rept. **1889**:158.

Bulb rots, *Bacillus carotovorus, Fusarium* **sp., etc.** We have seen bulbs in storage rot from both of these causes, the former as an ill-smelling, wet rot and the latter less so but with evidence of mycelium in the tissues that allowed the successive layers to slip apart easily. While no doubt some of the onions are

FIGURE 40. Melon downy mildew.

FIGURE 41. Oat stem rust.

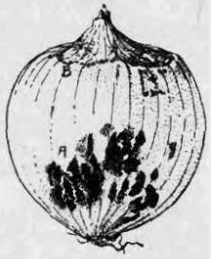


FIGURE 42. Onion smudge.

infected in the field and carry the disease into storage, lack of care in the manner of storing, as to depth in piles or crates and ventilation for heat and moisture, increases the trouble.

Rots of occasional plants by similar organism in the field, especially of seed onions, have also been seen. Such plants we have called yellow leg because of the premature yellowing of the stems due to the rotting of the bulbs and roots. Such plants are easily pulled from the ground because they lack firm roots to hold them in it and reveal the presence of the Fusarium or bacteria or both in the rotted tissues.

These troubles in the main result from an unfavorable season as regards excess of moisture, use of poor seed-bulbs or infrequency of rotation, two of these factors being under control of the grower.

Downy mildew, *Peronospora Schleideni.* While this may prove destructive it has rarely been found in this state, since we have seen it only twice in the last thirty years, and before that it was reported once by Thaxter. It forms whitish or yellowish spots on the infected tissues with usually a scant, white growth of the conidial stage that may become blackish because of the Macrosporium previously mentioned.

Sometimes it comes late in the fall with very wet weather, since in 1933 we found it causing considerable damage of plants in one field at Wilson, the leaves of which drooped down and died prematurely. The oospores are as usual hidden in the infected tissues but neither Thaxter nor the writer saw them in the specimens gathered.

Preventive measures are so doubtful and the fungus so rare that we have no practical suggestions to make here.

Gray mold. *Botrytis Allii.* *See* Addenda.

Rust, *Puccinia Porri.* We have never found the rust on the common onion but have seen it occasionally on the perennial Egyptian onion and on chives, *q. v.*

Smudge (Black spot), *Colletotrichum* (*Vermicularia*) *circinans.* This appears as more or less numerous, somewhat circular, black coatings, often with concentric rings of growth on the outer coats of the onion bulbs, being especially serious and conspicuous on the white varieties. It is an imperfect fungus whose mature stage is not known. It forms a black outer mycelium with erect, pointed, hairs covering a swollen base in which are produced the light-colored spores. It causes little or no rot but is objectionable on account of the black discoloration. (Fig. 42).

Part of the fungus can be removed by rubbing off the dry outer coats of onion. Some growers advocate dusting the onions in storage with dry lime. Storage should be under the best conditions to prevent development of the fungus by heat or moisture. Rotation is said to be helpful since the fungus can be carried over in the field.

Smut, *Urocystis Cepulae. See* Addenda. (Fig. 43).

Yellow leg mold, *Macrosporium parasiticum.* This has been seen as yellow or whitish spots on leaves and stems of seed onions which later become covered with the black fruiting stage of the fungus. *See* statement above under Black mold.

Abnormalities. Producing seed-onions, which are grown from large bulbs to produce seed from the flowers at the end of season, used to be quite a prominent industry in the Milford district of the state some years ago. Comparatively few fields, however, are now grown for that purpose. Under favorable conditions these large onions, often over two and a half feet tall, were a pretty sight when in full bloom in the fields but occasionally they produced scattered freak plants, especially in their blossoming stage, that are indicated by the following names with brief descriptions: *Bastard blossoms* indicate that instead of the normally, full, stiff heads there was produced a flopping, weak head with more elongated pedicels bearing fewer flowers and little seed. *Bulblet heads* are those that instead of producing normal, flowering heads form bulblets in their place, as often occur with wild onions. *Double flower heads* produced two heads a short distance above one another. *Elongated spathe,* which at first normally encloses the young head and then withers up and dies, is one that continues to grow in abnormal size and pushes aside the head. *Goose neck* is where the stem turns down and then curves upward again, often making several crooks before it decides where to grow. *Growth cracks* (*white ring*) show one or more parallel white cracks across the stem so that it is easily broken at these places; *see* Snapdragon.

All of these troubles are due either to poor bulbs or abnormal weather conditions and are usually so infrequent that they cause little damage.

Blasted heads and Prematuring. In the past seed-onions in the state occasionally failed to produce a normal or even a paying crop. The trouble seemed to be tied up with the character of the season. These unfavorable seasons were not always wet ones or due to wet weather at unfavorable times. Sometimes the trouble was due to prematuring of the onions before they properly set their seed following hot weather. Sometimes wet or foggy weather caused a growth of the Botrytis fungus mentioned under Addenda. Under either condition the heads developed a minimum amount of seed at maturity.

We were never able to lay the trouble entirely to the fungus. However, we did conduct for several years tests with Bordeaux mixture and got some increase of seed yield. The onions were sprayed several times, especially on the heads, both before and after the seed was set. On the whole, however, it did not seem to be a practice that would prove of much benefit considering the difficulties of spraying a large field.

Brittle (Brown root rot). Years ago we investigated a trouble of seedling onions that we called "brittle" because of the brittleness of the young leaves which were also often curled or even spirally coiled. The trouble seemed to start in the roots and affected the seedlings so seriously that their later growth was also interfered with. The trouble appeared in spots in the fields and seemed to spread especially in those fields continuously used in growing onions.

While a small amount of the mycelium of a fungus, apparently a Fusarium, was found in some of the infected roots, this was never definitely determined as the real cause. The trouble was not due to a lack of fertility since extra complete fertilization failed to improve the growth of the seedlings in the infected land. Considerable improvement, however, was seen by the use of formalin, lime and sulphur, especially the former, when applied to the soil before planting the seed. On the whole it now seems to the writer after his experience with a somewhat similar trouble of young tobacco plants, known as brown root rot, which also responded to formalin soil treatment, that it was one of those obscure soil conditions where response of the roots to securing the proper chemical elements for their normal growth was interfered with, resulting in their premature death, rather than that the trouble was due to any direct attack by a definite fungus. Although our reports do not state that the roots were reddish-brown in color it is our impression that such was the case as with the tobacco seedlings in their early stage.

Hail injury. As with other vegetables we have seen severe injury to onions, especially seed-onions, due to hail storms in midseason. The hail stones hit the large stems producing injuries that soon showed as white spots. Usually the direction from which the storm came could be told by the side of the stems on which the spots were evident. *See* Tobacco.

Orchard Grass

Ergot, *Claviceps microcephala.* This smaller ergot has been seen rarely in the heads of this host. *See* Timothy.

Rust, *Puccinia graminis.* Besides the above this is the only other fungus so far reported on orchard grass although it is quite likely that smut, *Ustilago striaeformis,* occurs here. *See* Timothy.

Pachysandra

Anthracnose, *Volutella* **sp.** The only disease we have seen on *Pachysandra terminalis* was brought in from one of the yards at Yale University where it was causing some trouble, mostly on recently transplanted plants. The disease was most conspicuous on the stems which had been cut back, the fungus working down on these as a dark-colored, dry rot and in time showing the fruiting stage as evident, flesh-colored pustules with an abundance of spores and occasional setae.

Evidently the disease came from the lower, old, yellowing leaves on which the fungus generally worked down from their tips causing a dark to light-brown spotting. Some of the leaves had apparently been injured at the tips by sun scorch. The fungus eventually produced on their under side the flesh-colored pustules of the spores, especially if kept in a moist place a short time.

The spores were hyaline, elongated, guttulate and chiefly 14–18μ in length by 2–3.5μ in width. They were more or less pointed and were borne on the exposed conidiophores which were about the same length or a little larger. We were unable to find any definite mention or description of this disease in literature, except we did learn of an article in Mycologia 21:137, published by Hutchinson of a new species described by him as *Volutella Pachysandrae.* This agrees somewhat with the symptoms of our disease but his statement that the spores are 2.3–6.1μ by .9–2.4μ seems to indicate that he had a different species unless in culture he got a much smaller development of the spores than we did on the leaves and stems of the living plants.

The fungus acts as does a weak parasite but if it should become troublesome the diseased stems and leaves should be cut off and destroyed and a Bordeaux spray applied beginning fairly early in the spring and following with one or two further treatments.

Palms

Bitter rot, *Gloeosporium rufomaculans.* This stage has rarely been seen on Kentia palms in greenhouses, attacking the leaves usually at their base and causing the tip to turn yellowish and gradually die. The fungus produces small, black, circular, fruiting bodies which ooze out the pinkish spores.

Cut off the outer leaf or two, if badly infected, spray with Bordeaux and stimulate new growth by fertilization. *See* Apple.

False smut, *Graphiola Phoenicis.* This has been seen in greenhouses and especially on imported plants of date (*Phoenix dactylifera*) and other palms. It shows on the leaves as small, cup-shaped, black elevations with a whitish top from which the spores are later liberated.

On the whole the fungus acts here as a weak, inconspicuous parasite but if it should become troublesome the diseased stems and leaves should be cut off and destroyed.

Pansy

Anthracnose and Leaf spot, *Colletotrichum Violae-tricoloris* and *Cercospora Violae.* These are two leaf troubles on *Viola tricolor,* very similar in appearance, producing discolored spots, finally usually whitish and often with somewhat colored borders, on which the fruiting threads may show as a more or less evident, blackish growth. The spots may be variable in number and even appear sometimes on the petioles and stems. It usually takes the microscope to distinguish the species, the first producing sterile, black setae or spines among the conidiophores and spores. They are prominent on greenhouse and garden plants, especially on the latter in wet seasons.

Their treatment is the same, spraying with Bordeaux mixture, best with potassium oleate as a sticker and spreader. If the plants are grown out of doors to be later taken in the greenhouse, it may pay as a precautionary measure to spray them even if no disease shows. If it does appear there or later in the greenhouse, pick off the worst infected leaves, be careful of watering and spray once every week or ten days to protect the new growth until danger is past.

Black root rot, *Thielaviopsis basicola.* This has been reported a few times on the roots, which may become badly infected, of pansies in gardens and probably also occurs in greenhouses. *See* Tobacco.

Damping-off, *Pythium debaryanum.* So far damping-off has been found on this host caused only by the above fungus but it has not usually been bad. *See* Spinach.

Parsley

Drop rot, *Sclerotinia sclerotiorum.* We found this trouble once on this host, *Petroselinum hortense,* in a greenhouse where the soil had become contaminated from drop rot on lettuce. It also became prominent on this host, the mycelium showing as an evident growth on the dead leaves at the base of the plants and also around them in the ground. *See* Lettuce.

Leaf blight, *Macrosporium Carotae.* We have recently seen one doubtful case of this trouble on parsley. *See* Carrot.

Leaf spot, *Septoria Petroselini.* This in appearance is very similar to the late blight of celery to which it is also closely related, the latter being once considered a variety of it, but on this host it has never proven as serious as that disease on celery. No perfect or asco stage is known. *See* Celery.

Parsnip

Bacterial soft rot, *Bacillus carotovorus.* We have seen this only in stored roots of *Pastinaca sativa* and then rarely. *See* Iris.

Leaf spot. *Cercospora Apii* var. *Pastinacae.* This is another case, similar to that cited under parsley, where a host and its fungus are related to celery and one of its fungi, this time to the early blight of the latter plant. This relationship is indicated by the scientific names of the fungous species and variety, as given here, which are derived from the scientific generic names of celery and parsnip. In this case, however, the injury to the parsnip often is almost as great as that shown on celery. In the last ten years the fungus has been reported at least three years as prominent.

No treatments have been tried by the writer. Spraying as for the blights of celery, however, should prove helpful if thought necessary and if given in time.

Nematode rootknot, *Heterodera radicicola.* This eel-worm trouble has been found occasionally in market-garden crops out of doors. Usually not much harm is caused because of the severity of the winter climate which largely prevents overwintering of the nematodes. The appearance of the infected roots, however, is marred as well as being objectionable if the nature of the injury is known.

Infected fields when they do occur should be planted the next year with a crop whose roots are not used for food, such as cereals or grasses. *See* Cucumber.

Pea

Anthracnose, *Colletotrichum Pisi.* This trouble of *Pisum sativum* has been found in the state only during the past two years. It is undoubtedly closely related to the anthracnose of bean. While in one collection we saw the characteristic setae of Colletotrichum, in another these seemed to be lacking, thus placing the fungus under Gloeosporium. This is a situation sometimes seen with the bean anthracnose and apparently some writers have considered the two as the same disease. The trouble is most serious on the pea in early wet weather before the pods are ripened. It produces irregular or roundish spots on the leaves and lesions on the stems running down even to the roots. We have not found the fungus as yet on the pods where it is said to occur. The plants are sickly and fail to grow to full size and produce, when bad, a very poor crop. The injury apparently opens the way for other stem and soil fungi to increase the damage. No perfect stage is known and the fungus has not yet been found carrying over on the seed.

In the case specially examined by us, the seed used appeared to be excellent and was planted on new land and the grower had not had previous trouble of this sort. This year, however, most of the peas on his old and new soil did not come up to standard, so the season, possibly the variety Laxtonian also, was a prominent factor in the failure. Attempts by us to lessen the trouble after it got a fair start by spraying with Bordeaux were not successful.

Black root rot, *Thielaviopsis basicola.* While we have found this fungus twice on the roots of garden peas, in both cases the Pythium fungus was also present. We believe that either of these fungi could have caused the rot and have no doubt that the former sometimes occurs here on the pea roots without the latter. *See* Tobacco.

Blight, *Ascochyta Pisi.* In contrast with the anthracnose of pea this is one of the old troubles of this host but it acts almost as seriously in some regions. With this fungus the chief injury occurs to the pods. While the usually whitish, circular spots with the embedded black, fruiting pustules appear more or less prominently on the leaves and stems, they become more evident, numerous and consequently injurious as sunken spots in the pods. In contrast with the preceding fungus the asco stage of this imperfect fungus has been found on the old, dead stems and is known as *Mycosphaerella pinodes,* though as yet we have not found it here. The fungus also carries over on the seed and the old stubble reproducing the conidial stage in the spring.

There have been so few complaints against the fungus in this state that we have never tried to prevent it by spraying. Writers state this is usually not very successful. On the other hand rotation and the use of clean seed give the best results.

Powdery mildew, *Erysiphe Polygoni.* So far we have seen this fungus only in its conidial stage as a white, more or less conspicuous coating on various parts of this plant but usually causing little serious injury. *See* Clover.

Root rot, *Aphanomyces euteiches.* Apparently from Jones and Drechler's investigations, this is the chief fungus of market garden peas which here in wet seasons rots the roots and produces sickly, spindling plants. The oospores that occur in the tissues of the rotted roots are so similar to those of *Phytophthora cactorum,* also found here, that the latter may be mistaken as the cause although it has a somewhat different life history.

Rotation, good seed, the use of the least susceptible varieties, as Horal, and frequent cultivation to dry out the wet top soil seem to be the best preventive measures.

Root rots, *Pythium debaryanum, Rhizoctonia Solani* and *Fusarium* sp. All three of these fungi act much as does the preceding one in rotting the roots and stems

just at and beneath the soil. The infected plants are generally stunted, turn yellow and usually die before they have produced the pods. Wet weather and too deep covering of the seed aid these fungi, commonly present in the soil, to take advantage of these conditions. Usually a microscopic examination of the rotted tissues is necessary to determine the particular fungus that causes the trouble and sometimes two are found to be present.

These root rot troubles have been seen chiefly in small garden plots and treatment may be given there as described under similar troubles of Sweet peas.

Fertilizer burn. We have had a few complaints of cases where the roots and base of the peas turn reddish-brown and die as if from one of the preceding fungi but with no indication of their presence either through mycelium or spores. In such cases it usually happens that the chemical fertilizer, applied either in drills or broadcast in the furrows, has come into too close contact with the germinating seed as it pushes up through the soil with resulting injury to the tender tissues. Usually the grower blames the character of the fertilizer rather than the manner of its application as the real cause of the trouble. Sometimes the seed fails to germinate under such condition. We have experimentally produced similar trouble with a chemical fertilizer scattered over the seed in the furrow.

FIGURE 43. Onion smut.

FIGURE 44. Peach brown rot.

FIGURE 45. Peach curl.

Peach

Bacterial leaf spot, *Bacterium Pruni.* This trouble of *Amygdalus Persica* was first found in this state on the peach leaves about the time that the late Dr. Smith first described it on the green fruit of plums elsewhere. The damage here is chiefly to the leaves showing as small, reddish-brown spots that when wet are semi-pellucid and often fall out later, giving the shot-hole effect. When abundant the leaves often turn yellow and fall off the trees. While the germs carry over on the twigs and sometimes cause small, sunken spots in the fruit, on neither of these are the injuries conspicuous. *See* Plum.

Brown rot, *Monilia cinerea.* The brown rot is the worst trouble of peaches in this state being bad on early varieties and especially so in wet seasons when the fruit ripens. It also forms its asco stage on the old mummies half buried in the ground. For details *see* Cherry. (Fig. 44.)

In May, 1933, it was very bad at the blossom time, killing the flowers and invading the young branches. It also developed its conidial spores abundantly on the infected leaf-curl leaves that occurred commonly that year. **This was unusual.**

Crown gall, *Bacterium tumefaciens.* This is found here chiefly on nursery stock but does not seem to cause much damage in the orchards. *See* Rose.

Die back and Dead limb fungus, *Valsa leucostoma* and *Cytospora Persicae.* We have seen one or two cases in exposed orchards where evident cankers, on the small and large limbs often at the base, were not due to the brown rot fungus but showed the above Ascomycete or its probable conidial stage Cytospora. However, we have had the suspicion that these cankers may have had connection with winter injury, especially since the Cytospora is not uncommon on dead limbs or trees where it was not the cause of death and was evidently a saprophyte.

Frosty mildew, *Cercosporella Persicae.* While Thaxter years ago once reported this trouble so prominent on an orchard tree that defoliation took place, the writer has seen it only very rarely and then never prominent. The infected leaves show yellowish or even sometimes reddish discoloration on their upper surface with a short, white, powdery growth of the imperfect fruiting stage on the under surface. Apparently nothing has been found out concerning its asco stage and little concerning its life history. In recent years it has never needed attention here for its prevention.

Fruit rots, *Botrytis cinerea. Rhizopus nigricans.* Both of these fungi have been found on ripening peaches usually those that have fallen on the ground, though rarely have we seen the former on fruit on the trees or the latter on fruit shipped here in car lots from the south. For description of the former *see* Geranium and of latter *see* Sweet Potato.

Leaf curl, *Exoascus deformans.* Here is another peach fungus that years ago was much more prominent than it is today. Apparently spraying with lime-sulphur for scale has considerably lessened its appearance. The fungus is chiefly a leaf inhabiting species infecting the leaves just as the buds begin to open or soon afterwards. When fully grown, the infected leaves show thickened, curled or wrinkled tissues and are pinkish or whitish when fruiting. The naked asci with the ascospores are produced on the upper leaf surface, at first just beneath the cuticle but soon entirely exposed. The leaves may be entirely or only partially invaded and in the latter case the infected tissues are in strong contrast with the normal, thin, green tissues. If the infection is bad the tree may be partially or entirely defoliated and a new crop of leaves developed later that is almost entirely free from the disease. The fungus carries over in a rather obscure way on the young, swollen twigs. The blossom and the fruit may be injured, the fruit often dropping off when very young or on maturing showing a more or less distorted growth with the infected surface free of hairs. (Fig. 45.)

The treatment for San José scale, spraying with liquid lime-sulphur about 1 to 10 just before the buds begin to swell in the spring, also usually takes care of the trouble.

Powdery mildew, *Sphaerotheca pannosa.* This may show in the early season as an evident, whitish, conidial and mycelial growth, with possibly a few embedded perithecia of the mature fruiting stage, on the young twigs and leaves of nursery and orchard trees. We have had one complaint where the owner had trouble controlling it in a peach orchard by the ordinary spray treatment but usually the dormant spraying with lime-sulphur and the later summer strength of the same should control it. *See* Rose.

Scab, *Cladosporium carpophilum.* The round black spots, about a quarter of an inch in diameter, are familiar to every one who buys peaches. Sometimes these are isolated spots but when bad they may run together giving an extended black coating usually at the upper side of the peach next to the stem end. This is because this imperfect fungus is carried over on the young twigs and the first infections of the fruit come from these. The fungus appears rarely on the leaves in an inconspicuous, fruiting stage. The spots on the fruit usually do not become conspicuous until it is half grown but infection takes place even earlier. The fungus does not rot the fruit but may stunt or distort it when abundant and when very bad causes it to crack and thus opens the way for rot by the Monilia fungus. Even when full sized the black discolorations affect the sale of the fruit. The asco stage of the fungus has never been determined though it is most likely to come

under the Venturia genus if found. The conidial stage consists of short, black hyphae on the surface of the host bearing spores of about the same color. (Fig. 46).

Control by spraying or dusting should start soon after the young fruit begins to show and should be continued to include the brown rot that appears prominently as the fruit begins to ripen. This means three or more treatments according to weather conditions.

Stem canker, *Phoma Persicae.* This trouble has been seen only in nurseries or on young orchard trees. A sunken canker of darkened tissue is formed on the stem, usually at the nodes, which if it encircles will kill the parts above. The embedded, black, fruiting dots are not usually very conspicuous though the spores may be produced abundantly in them. The trouble may be prominent on the infected trees but these usually are not common.

The infected branches should be cut off or the badly injured seedlings be pulled up and these infected parts be burned.

Wood rots, *Fomes applanatus,* etc. The Fomes and other less conspicuous Basidiomycetes have been found on the bark and wood of dying or dead orchard trees. So far as noticed none of these fungi are the direct cause of the death of the trees, coming on them after winter or other injuries and developing only as saprophytes. *See* Maple for the specific fungus mentioned.

Crown rot. This is a trouble, scarcely a true rot, that appeared in a few orchards a number of years ago showing where the stock had made a large, somewhat irregular growth greater than the scion above. Such trees in time often broke off at these weakened places. Some signs of the presence of the mycelium of a fungus was seen in some of the specimens but no evidence was obtained that this was of a parasitic type. Apparently the trouble was due to uncongenial growth and union of the stock and scion of such trees, as has been seen in cherry, lilac and some other woody plants. The trouble has not been called to our attention in recent years.

Growth cracks. In certain wet seasons these become more or less common on the ripening fruit but vary considerably on different varieties being especially common on the earlier ones. *See* Snapdragon.

Gummosis. To the writer's mind this trouble is usually the result of winter injury in this state. The bark becomes more or less roughened and injured. The wood sometimes shows indications of winter blackening and spots on the branches develop gummy exudations with no definite indications in them of a cause of the trouble. Any local injury to the bark or sapwood is likely to develop such exudations and they are specially evident on the main stem below the ground as the result of peach borers.

Hail injury. This has been seen several times in local orchards developing bruised or sunken spots on the fruit and especially in young orchards showing evident injury to the young tender growth of the trees on the side of the branches from which the storm came.

Leaf fall. In dry summers, especially when there has been a fairly full development of foliage, the lack of moisture is shown by the yellowing and sometimes by the severe dropping of the foliage to cut down loss of water through the leaves.

Little peach. This is a trouble very similar to Yellows, but not so common here, the main difference as we have seen it being in the smaller size of the peaches and in delayed rather than premature ripening. The effect on the foliage is much the same. In fact we do not always distinguish between the two troubles here. Of course little peach must not be mistaken in the orchard for trees where the scion has died and a seedling growth developed below the grafted bud, since such trees usually produce small, late peaches but do not necessarily show evidence of foliage injury. *See* Yellows in Addenda.

Spray injury. The peach tree is much more liable to injury from spraying than the apple, or even than some varieties of cherries and plums, so care has to be used as to the kinds and strength of spray materials used on it. This is true when lead arsenate is used in fungicides even with lime-sulphur. Injury may result to the young twigs, showing later as reddish-brown spots especially at the base of the leaves, thus often confusing the grower as to the cause. When in foliage discolored spots on the leaves, with after development of shot-holes, leaf yellowing and defoliation, may also be caused. The leaf injury may easily be confused with the bacterial leaf spot without a microscopic examination. Of course there are certain sprays, as Bordeaux mixture and certain commercial products, that should never be used when the trees are in foliage. Lime-sulphur has to be used in a very weak summer strength, avoiding the lead arsenate if possible, and even lime-sulphur dust has sometimes caused injury where this arsenate is added. Atomic-sulphur and self-boiled lime-sulphur have in the past given fair results as fungicides with the least injury but these are now rarely used, the latter chiefly because of its inconvenience. Dry-mixed sprays seem to be the most satisfactory forms for use.

Winter injuries. Winter injury of peach trees that have not received proper cultivation and fertilization is perhaps even more common and severe than those that have received good attention. Of course late fertilization, where the wood goes into the late fall in a soft condition, is even worse than no fertilization at all in this respect. Likewise the location of the trees as to certain exposures, elevations or even depressions, direction of wind and sun, amount of water in the soil, the character of the mulch (vegetable, soil or snow), the low temperatures of certain winters or sudden changes of cold and warm spells, all have much to do with the kind and severity of winter injuries in Connecticut. This state is near the northern limit of successful peach growing and so care must be given as to the districts in which orchards should be located.

Collar girdle at the base of the trees is one of the common troubles in severe winters, especially when water gathers around the base without proper mulching or banking. We have also seen young seedling trees stripped of their buds where ice and snow freezing around the trunks and limbs have carried down these buds with their attached bark when the snow beneath melted before the frozen crust. *See* Apple for further details.

Yellows. *See* Addenda.

Pear

Bitter rot, *Gloeosporium rufomaculans.* We have seen this only rarely in the picked fruit of *Pyrus communis* and then not causing much damage. It seemed to be chiefly a saprophyte.

Black rot, *Sphaeropsis malorum.* Here again is a trouble that is less common on the pear than on the apple, *q.v.*

Brown rot, *Monilia cinerea.* As with the apple this is not a very common or serious trouble, showing chiefly on the matured fruit. *See* Cherry.

Crown gall, *Bacterium tumefaciens.* Crown gall has been seen here only once on pear and then on nursery stock recently imported from France. *See* Rose.

Downy mildew rot, *Phytophthora cactorum.* This trouble was first seen here in 1919 on stored fruit sent to the Station to determine the cause of rotting. In this case the rot seemed to start at the core and extend outward to the apparently healthy skin. The rot was later found on fallen pears on the ground under the Station's trees and seemed to be fairly common under these conditions though contamination by other fungi soon occurred. The trouble shows on the outside merely as an ordinary brown rot with no evident growth unless the fruit is protected to allow an external, whitish development of the mycelium. So far we have not seen the oospores in these rotted pears although they were readily produced in artificial cultures made from the mycelium of the infected tissues. There is little doubt, however, that they finally develop in the infected tissues. The same trouble was later also seen on the apple and in this case it was even seen on the fruit still attached to the lower part of the tree. We have also reported it on corn, ginseng, pea, sweetpea, strawberry and the same or a very similar species on peony.

Fire blight, *Bacillus amylovorus. See* Addenda.

Fruit rots, *Botrytis cinerea, Cephalothecium roseum, Penicillium expansum.* All three of these are semi-parasitic fungi that occur on other hosts but on this one chiefly as rots of the stored fruit, especially if it has been previously injured and is stored under unfavorable conditions. They are all imperfect fungi whose asco stages have never been discovered. Their exposed fruiting stages when present can

be told by the appearance of the spores, in the first having a grayish, in the second a pinkish and in the last a greenish color.

Leaf-fruit blight, *Entomosporium maculatum.* This fungus occurs here on both the leaves and fruit of the pear but is less common and injurious than on the quince, *q.v.*

Leaf spot, *Septoria pyricola.* This has been seen occasionally, usually causing little injury, as small, grayish, sub-circular or angular spots with purplish borders on the leaves. The imperfect stage develops as embedded fruiting dots on these, and later on the dead leaves the asco stage, known as *Mycosphaerella sentina,* is said to appear. Burning the old leaves, therefore, should help to take care of the trouble where necessary.

Powdery mildew, *Sphaerotheca pannosa?* This was found once on a nursery inspection, invading the tips of a single tree, with the conidial stage only developing. We are, therefore, in doubt as to its exact identity but class it with the same mildew occasionally found here on the peach, though it might have been one of the two species of Podosphaeria that have been reported on this host elsewhere.

Rust, *Roestelia globosa.* Both Thaxter and Hunt have reported this rust on the leaves of pear and the writer has seen it rarely as well as have occasional nursery inspectors. All of our specimens, however, except Thaxter's, show only the pycnial stage and even this sparingly. Thaxter in 1890 wrote of it as follows: "The several varieties of pears of the Japanese strain (Kieffer, etc.) have shown themselves very susceptible to injury by one of the rusts derived from the red cedar, . . . the finger-like Roestelia stage developing from the under side of these spots during August and September." *See* Hawthorn.

Scab, *Fusicladium pyrinum.* Here is a troublesome fungus of the pear, especially on certain varieties, of which the Flemish Beauty is most severely injured. This imperfect fungus occurs on the leaves and fruit doing the greatest damage to the latter, much as does the related scab on apple. However on the young twigs, at least on the Flemish Beauty, the small fruiting pustules it produces are much more evident to the naked eye. Recently we have seen these pustules just split open that were producing new, mature conidia on April 15, some days before the flower or leaf buds started to open. As shown by Aderhold years ago the asco stage also develops on the old leaves in the spring, much as does the apple scab, being known in this case as *Venturia pyrina.* We have rarely collected this stage, apparently chiefly because we have not looked for it carefully. **(Fig. 47.)**

Spraying, as for the scab of apple, should also control this trouble but only the very susceptible varieties need to be treated.

Sooty blotch, *Gloeodes pomigena.* This occasionally shows in late, wet seasons in its blackish mycelial growth on the fruit. *See* Apple.

Spray injury. Spray injury has occasionally shown on pears especially those that have been sprayed with Bordeaux mixture and even with lime-sulphur. However, as pears are not so commonly sprayed here, much less injury has been reported than on apple or peach.

Winter injury. We have not seen or heard of as much winter injury to pears as to apples, partly because they are not so commonly grown, but apparently also because with less cultivation and fertilization and with fewer varieties grown, they go into the winter in a much harder condition.

Sturgis as early as 1895 described bands or blotches occurring on the fruit as due to late spring frosts. *See* **Rept. 1895: p. 190.**

Pea Shrub

Fasciation. On *Lespedeza formosa* (*L. Sieboldi*) in a nursery in 1917 specimens were found showing stems that were greatly flattened and at least eighteen inches long but they were broken off at the lower end of the flattening and so may have been longer. The leaves were scattered along this abnormal stem and its tip was divided into two tips each with a double coil to the same side.

Peony

Downy mildew rot, *Phytophthora* sp. We first found this trouble in 1923 and have seen it several times since on the petioles of *Paeonia officinalis.* We have not studied the fungus sufficiently to determine whether or not it is distinct from *P. cactorum.* It appears on the young peonies in the spring as they push up through the soil. The upper parts only may be killed or the infection may be limited to the basal parts in which the upper free parts may later die as a result of this basal infection. The mycelium can be found in the invaded tissues but as yet we have not recorded the presence of the oospores there though they later were obtained in the artificial cultures made from the mycelium. We have seen this trouble in wet places or during wet, early weather on certain varieties such as Prince of Wales and Queen Victoria but do not know if these are more susceptible than other varieties. Sometimes on the rotted petioles Botrytis also appeared, in which case it is somewhat doubtful as to which was the primary cause.

Keep the plants and earth as dry as possible as the former push up through the soil in the spring and do not select wet or too shady spots for their planting. Destroy any injured or dead tissues. If rot starts select only healthy stock that is free from dirt to transplant to a new and drier location. It might be well where the trouble has occurred to spray such plants and the soil with Bordeaux mixture as the plants push through the earth the next spring.

Leaf blight, *Botrytis ?Paeoniae.* There is some question in the writer's mind, not having studied this trouble especially with pure cultures, whether this fungus really is distinct here on this host or is merely another form of *B. cinerea* to which it bears close relationship. Both species are recorded on this host from the United States. Some of the writers claim that the conidiophores and spores are somewhat different and the sclerotia are smaller and more regular. The few sclerotia we find on the stems of the specimens we have saved are about 1 mm. in length but the conidiophores and spores are either not abundant or not well preserved.

The disease may appear on the young growing stems in the early season rotting them at the base when the parts above also die with or without infection. It is on or within these rotted stems that the sclerotia are found. More commonly we find the disease, especially on plants in shaded places, causing evident but variable sized spots, showing on both sides of the leaf and varying from light brown to dark purple especially on the upper side. At times no fruiting stage may show or it may develop under favorable conditions, especially on the under side of the leaves or even on the stems, as the erect, fruiting threads characteristic of the gray mold, though often less dense, as seen on the geranium, *q.v.*, and other hosts.

Leaf mold, *Cladosporium Paeoniae.* This trouble shows on the leaves in spots quite similar to those caused by the preceding fungus. Sometimes the spots do not show the olive-brown, fruiting stage at all, which leaves one more in doubt as to the cause. Like Cooke of England, who also records the presence of the fungus there, we are in doubt of its true parasitic nature since it might come on through Botrytis injured spots as a common saprophytic Cladosporium to which a new name has been applied when found on this host.

Fasciation. The only specimen we have of this trouble on the peony was collected in June, 1917, at Whitneyville and merely shows a slight flattening of the stem bearing an apparently normal blossom. *See* Asparagus.

Mosaic-like mottling. We have seen this trouble on individual leaves of plants where there was a very definite pattern of narrow mottling giving an effect as if caused by some insect traveling over and injuring the tissues when they were very young. Yet there was no certain evidence of any insect or its remains to show that it was the primary cause.

Winter injury. Occasionally in the spring we have seen the roots of peonies that failed to grow or made a sickly growth of plants. Such roots show that their tissues have been partly or largely killed as indicated by their reddish-brown or rotted condition. In some of these we have seen the dark mycelium of some fungus present and in others nothing at all. As this trouble is most evident after severe winters, we judge that winter injury is the usual cause, especially as we have never seen any fruiting stage on the infected roots.

Pepper

Anthracnose, *Gloeosporium rufomaculans* (*G. piperatum, Colletotrichum nigrum*). Sturgis first reported this trouble here on peppers, *Capsicum annuum,* in 1899 as causing 25% rot of the fruit in certain fields. He called the fungus *Colletotrichum nigrum* since the fruiting pustules produced black setae, around the base of which the pinkish spores oozed out from the tissues beneath. Later the writer reported it as *Gloeosporium piperatum* since the specimens seen by us did not have the setae and the pinkish spore masses were even more evident. Botanists have since decided that these are not distinct species but variations of the same one (as given here in the heading) which also has a great variety of hosts. On this particular host it has been found only on the fruit, causing brown or blackish spots according to its fruiting condition.

Spraying is not very satisfactory; pick off and cart away the infected fruit. *See* further statements under Apple.

Bacterial soft rot, *Bacillus carotovorus.* The soft rot is rarely reported on the green fruit. *See* Iris.

Black spot, *Alternaria* sp. We have had one case of small, black, rotten spots appearing on the red fruit that developed Alternaria spores only after being kept a few days under a bell-jar. Apparently this trouble has been reported elsewhere.

Gray mold rot, *Botrytis cinerea.* On the green and ripening fruit in wet seasons, this has been seen causing a brown rot often with evident growth of the fruiting threads. *See* Geranium.

Seedling rots, *Pythium debaryanum, Rhizoctonia Solani, Sclerotinia sclerotiorum.* All three have been isolated as causing the death of young plants in seed beds and flats in the spring. *See* Damping-off under Spinach.

Mosaic. Occasionally we have seen mosaic in the fields and gardens where it caused considerable injury although the mottling effect is not so evident as on some other plants. We have produced the disease on healthy plants of tobacco with the juice from both the leaves and the fruit of the diseased peppers. *See* Cucumber and Tobacco.

Scald. We have occasionally seen this on one side of the fruit following very hot weather. *See* Apple.

Peppermint

Rust, *Puccinia Menthae.* While we have found this rust common on the wild species of the mint family, it has been less common on those cultivated, especially on the peppermint. Yet it was on cultivated plants of this species, *Mentha piperita,* that the I stage occurred the first time it was found in the state. This was May 23, 1933, at Westville. The stems of the plants were somewhat swollen for a considerable distance, as if the fungus was perennial on them. On this swollen part were seen numerous outbreaks of the cluster cups, filled with orange spores, and showing the small teeth at their edges. The I stage is also said to occur on the petioles and on the under side of the leaves. This is the earliest stage of this rust and no other stage occurred at this time on these specimens. *See* Beebalm for other stages.

Periwinkle (Myrtle)

Black wilt, *Undetermined fungus. See* Addenda.

Persimmon

Scab, *Fusicladium Levieri. See* Addenda.

Petunia

Mosaic. We have found this trouble several times on *Petunia hybrida* and frequently have produced it from juice from mosaic tobacco plants, *q.v.* However, this is the only disease we have recorded for this host and those reported elsewhere do not seem to be serious or numerous.

Phlox

Anthracnose, *Vermicularia phlogina.* We are not sure that this fungus was the cause of the death of plants sent us in 1932 from a garden in Washington, Conn., but it was the only fungus we could find in the stems which had apparently died from a rot at their base. Two species of Vermicularia have been reported for Phlox, *V. Dematium* a species on a variety of hosts and apparently a saprophyte and *V. phlogina* described originally as found on the leaves. Our specimen agrees with this latter as issued in Fungi Coll. no. *4800* where it occurs on the stems as well as on the leaves. The fruiting stage of this fungus shows as small, often numerous, black tubercles with setae, beneath which are found the spores. In 1924 at Westport and in 1926 at Wallingford there were also collected on dying stems of *Phlox paniculata* specimens of Vermicularia that seemed to have some connection with their premature death.

Crown rot, *Sclerotium Delphinii.* This was reported once as rotting off the base of the plants. *See* Larkspur.

Leaf spots, *Cercospora omphakodes, Septoria divaricata, S. Drummondii. See* Addenda.

Powdery mildew, *Erysiphe cichoracearum.* While we have reported several different species of powdery mildews in this bulletin, each usually with several economic hosts, this one seems to have more than any of the others and it certainly has as many more on our wild plants. Most of these hosts, both cultivated and wild, belong to the Composite and Gourd families, as is shown by the following which are listed here: chrysanthemum, cucumber, dahlia, goldenglow, muskmelon, pumpkin, rosinweed, salsify, squash, sunflower, verbena and zinnia. On many of these hosts only the conidial stage has been found and often in such cases the white coating of mycelium and conidial spores is not so evident or thick. On the phlox, however, the coating of the mildew is evident, often as a heavy coating, especially on the stem, and the asco stage is usually present as small, black perithecia embedded in or on this growth. Two large ascospores in each ascus are characteristic of this species. We have often wondered if the absence of the asco stage indicates that the host in such cases is one of recent origin so far as infection by the mildew is concerned; however, we know in some cases it is due to the very late appearance of perithecia in October after frost has largely killed the leaves.

We suggest the same preventive treatment as given for the leaf spots though the number of sprayings required may be greater and for a longer period to meet with success.

Stem-leaf nematode, *Tylenchus Dipsaci.* This is distinct from the common root nematode already mentioned here on the roots of a variety of hosts. It was sent to the Station once in 1928 from Darien showing infections on the stem and petioles and causing a decided malformation of the leaves with elongated petioles and in some cases almost no blades. Specimens were sent to Dr. Steiner, of the U. S. Department of Agriculture, who determined the species of the nematode as given here. He wrote as follows:

"This pest has lately been mentioned several times on phlox in Europe but, as far as we know, this is the first time that it has been observed on the plant in this country. We do not know a sure way to get rid of this pest on these plants; perhaps the best is to cut the infested tops of all the stems off and destroy them, but some forms of the nema might stay in the soil and the crowns of the plants and make trouble the next season. It would, therefore, be well to watch the plant and, if the trouble should come up again, take out the entire plant and destroy it. This is the same nema that is commonly called the 'stem nema' or the 'bulb nema.' It is found in a number of host plants like narcissus, hyacinths, onions, alfalfa, clover, strawberries, etc."

Drought injury. As already indicated under Leaf spots we have had specimens of phlox sent in for examination when the fungus present or the direct evidence of insect injury were not sufficient to account for the poor condition of the

plants. Usually these complaints have been in dry years or dry periods when the yellowish, sickly or dried-up leaves might be due to the unfavorable amount of moisture in the soil. We shall continue to give such a designation until we have some proof that the trouble, which sometimes shows under more favorable moisture conditions, is not due to some obscure early injury by sucking insect or to a virus carried by them.

Mosaic? We have occasionally seen mottled leaves on certain sickly plants when we were not sure whether they were the result of direct insect attack, probably lice, or were of the nature of a true mosaic injury.

Pines (other than White)

Black rot, *Sphaeropsis malorum.* To those to whom a new host-genus means a new species for the fungus found on it, this fungus might be called by some other specific name. The few times we have found it on pine has been on *Pinus austriaca* and then under such conditions that we believed the injury to the buds and stem had been caused primarily by winter injury, *q.v.* *See* also Apple.

Needle blight, *Hypoderma Desmazierii.* We have seen this fungus a number of times on the leaves of *Pinus rigida*, where their free ends had apparently been injured by winter or drought, showing a reddish-brown discoloration. The fungus develops as evident, slightly elevated, oblong to linear, black lines through the center of which, with age, dehiscence occurs for the discharge of the ascospores. We question how much the fungus is responsible for the injury to the leaves since some leaves show the presence of its fruiting stage and others do not. It seems to us to be a weak parasite, or possibly even a saprophyte, that attacks the leaves only when injured from some other cause. Apparently little work has been done on this Ascomycete to determine its real nature as a parasite.

Needle cast, *Lophodermium Pinastri.* This trouble is so near to the preceding in external appearance that it takes a microscopic examination to distinguish them. They can be determined through their ascospores, the former being one-septate and broader than the thread-like single cells of this one. Even this examination may be insufficient since with both of them the maturity of the spores may not take place until they have been shed from the trees. This is true especially of the Lophodermium, known as Needle cast.

We found this Lophodermium on drought injured trees of *Pinus resinosa* in a forest plantation recently. A very dry year, which was preceded by a very wet one, had caused an unusual dropping of the older, lower and closely shaded leaves in this plantation of young trees about fifteen feet high. Many of the lower branches were dead but often, too, higher ones, presumably from shading, competition and the unusual drought conditions, and many of them still had the dead leaves attached. Not many of these leaves, however, showed the fruiting stage of this fungus present though those on the ground showed it commonly and often with mature ascospores. Mycelium of some fungus was found in the dead branches and somewhat in the base of the attached leaves. If this fungus was the cause of the leaf fall, it was more as an after effect of the dry season than as a direct parasite since there was no evidence of its spreading to the younger, living leaves. The same fungus apparently was also seen in winter-injured nursery trees of *P. austriaca*, though in this case the leaves were still on the young trees and had not fully developed their ascospores.

Rusts (Pine-Goldenrod), *Peridermium acicolum, P. delicatulum.* By far the most common of these two leaf rusts is the first mentioned which occurs on a great variety of wild goldenrods and asters (or rarely on cultivated asters, *q.v.*) in its II and III stages where it is known as *Coleosporium Solidaginis.* In the fall, infection of the needles of the pines, as shown by our infection experiments, takes place from the germinating telial (III) spores from one of these alternate hosts. These spores produce secondary spores or sporidia that are blown to the pines where evident infection of the needles does not show until the next spring or early summer as the white, cluster-cups of the I stage. These show more or less abundantly, in an irregular row along the length of the needles. These fragile cups are somewhat flattened, about one-eighth of an inch high and slightly less wide

and break open irregularly from their tips, disclosing the orange-yellow spores of the I stage that carry the rust back to the goldenrods, etc., at this time. Originally found here only on the native species of *Pinus rigida*, the rust has recently appeared even more abundantly on the needles in plantations of the red pine, *P. resinosa*, and in 1932 it was collected once on *P. Banksiana.*

The second needle rust of pines given here also has as its hosts a few species of goldenrods (chiefly section of Euthamia) with II and III stages only to be distinguished from the preceding rust by microscopical examination. It also produces the I stage on the pine needles, so far only seen here on *P. rigida*, but in this case the smaller cups scarcely show above the infected tissues.

Neither rust is perennial on the pines but requires new infection of the needles each year from the alternate hosts. The control of them on the pines, therefore, is confined to getting rid of all goldenrod and asters, especially infected ones, in the plantations. After the pines reach some size, this means chiefly destroying these herbs at their edges since the shade within will usually crowd them out there.

Rust (Pine-Oak), *Peridermium cerebrum.* In this case, the rust is one inhabiting the stems and limbs of the pines, especially young plants; while it is found there only in its I stage, this is perennial on its hosts. It shows usually as round galls surrounding the stems and reaching from one to three inches in diameter. In time these galls may cause the death of the parts above, as one frequently sees them further south on young dead seedlings. Sometimes more than one gall is found on these seedlings. Early in the year these galls, when mature, show the compound peridium as a white coating (often in separated blisters as individual peridia) surrounding these woody swellings, and beneath this coating are developed the yellowish spores. These spread the disease to the oak leaves where the II and III stages develop much less conspicuously. While this trouble seems to be common in the pine barrens farther south, in Connecticut it has rarely been found on either host. It was seen first in the Station's plantation at Rainbow on *Pinus Banksiana* and native *P. rigida*, again on this latter host as mentioned under oak, *q.v.*, and still later in a water company's plantation on *P. ponderosa.*

So far all that needs to be done for control here is to destroy the occasionally infected pine seedlings.

Rust (Pine-Sweetfern), *Peridermium Comptoniae.* This is another perennial rust on pine stems and is easily distinguished from the preceding by the fusiform swellings on the stems and branches and by the very definite, tongue-shaped, temporary peridia that break out individually on the infected tissues. These peridia of the I stage stand up as white, fragile elevations, a quarter of an inch in height, and when they break open at the top they often show a definitely toothed edge from which the orange-yellow spores escape.

The host species of the pines is rather extended, as indicated so far by the following found in Connecticut: *Pinus austriaca, P. Banksiana, P. Pinaster* (*P. maritima*), *P. montana* var. *Mughus, P. Murrayana, P. ponderosa, P. rigida, P. sylvestris.* These have been found either in the natural woods, forest plantations or nurseries.

With this species the writer and Dr. McCormick, as with the white pine blister rust, have proved that the spores from the III or Cronartium stage infect the pine needles, producing the yellow spots and the sclerotial masses from which the mycelium gradually works down the bundles into the stems to become perennial there. In this case the alternate hosts are limited to the wild sweetfern and its close relatives (Myrica formerly Comptonia).

In this state, the chief preventive measures are to destroy the sweetfern, especially if infected, in the vicinity of the pines and certainly to do this in the vicinity of the seed beds and nurseries; the occasional infected tree or its branch in forest plantations or in cultivation should also be destroyed.

Seedling rots, *Rhizoctonia Solani, Pythium debaryanum.* Damping-off of pine seedlings occurs frequently in the nursery and forest seedbeds and according to our experience in this state the *Rhizoctonia fungus* is by far the chief agent. Some pine seedlings seem to dampen-off more frequently and abundantly than others though this may be merely due to their surroundings or the frequency with which they are grown. We have recorded injury in the seed beds from the Rhizoc-

tonia to *Pinus resinosa, P. Strobus* and *P. sylvestris.* In our crock experiments with pine seedlings grown for other purposes, we have used about forty different species and we have lost many of the individuals of these by damping-off. Besides those already mentioned here, those definitely recorded as killed by Rhizoctonia are *P. austriaca* (*P. nigra*), *P. densiflora, P. excelsa, P. palustris, P. pinaster* and *P. ponderosa.*

A different type of injury was called to our attention by one of the nursery inspectors who found imported seedlings of the umbrella pine where some trouble had been caused by the Rhizoctonia creeping over the seedlings, due to conditions favoring its development because of the manner of shipping by boat.

We have little data of injury to pine seedlings through the Pythium though this has been reported elsewhere as sometimes serious.

Sterilization of the soil of the seedbeds before planting, care in the use of water and shading, keeping the top soil dried out by frequent cultivation and spraying the seedbeds as the seedlings come through the soil and for the necessary time afterward, have all been suggested as possible means of controlling these two troubles. *See* Potato and Spinach.

Mice girdle. As with apple and other trees in nurseries and orchards and even wild trees along stone walls, mice sometimes girdle the base and roots of the young pine trees in plantations especially when well covered with snow. A few cases have been called to our attention, one particularly of young Scotch pines in a plantation at Union in the northeastern part of the state. *See* Apple.

Sun scorch. We have seen a few cases in seedbeds where seedlings, not properly protected by shade, were injured, showing the trouble on the needles and sometimes the tips of the seedlings when the roots seemed to be sound. Somewhat similar injury may be caused when beds are not watered in drought times though the injury there is more likely to show death of the whole plants. We have also seen occasional cases of leaf injury to certain large trees, especially native *Pinus rigida,* similar to the so-called white pine blight, that was apparently due to drought conditions.

Another type of sun-scorch was seen in a plantation of large trees of *P. sylvestris* in the late summer of 1931 where the trees, except those on the north side, showed evident injury to this year's needles especially exposed to the sun and particularly those at the top of the trees. This injury was evidently caused by two unusually hot days late in June exaggerated on the trees in one place where a large stone pile was close to them and reflected the heat. This sudden and severe heat killed, by drying out, the tender growing bases of the young needles so that with their collapse the harder tissues above died while still green but short of their normal length. Many of these new needles of the shoots had fallen off, leaving them bare except for the normal leaves below produced in previous years. We have seen a somewhat similar injury to white pines that seemed to be due to late frost injury.

Winter injuries. Cases have been seen of young trees, sometimes apparently not entirely hardy, as *Pinus excelsa,* that following the winter have died suddenly without evidence of fungus or insect injury. Cultivated and fertilized trees in the nurseries most frequently show such injuries.

We have also seen cases of *P. austriaca,* especially on sea-shore estates, where the leaves and buds of the new shoots were severely injured (often killed or followed by weak spring growth), the injury being aided perhaps by ice from storms off the water. In 1932 we received especial complaints of injury to this same species from New York state, particularly on Long Island, and from Connecticut. In these cases the drought of the preceding years may also have aided the injury. On the various specimens seen during different years, we have occasionally found on some of the leaves or dead stems the fruiting stage of Sphaeropsis (*q.v.* here under Black rot) but we believe that this came on as the result rather than the cause of the injury.

Likewise we have seen late frost injury to the young leaves and winter injury to the old leaves producing the so-called white pine blight type of injury, *q.v.*

Another type of winter injury arises, especially in winters with alternate thawing and freezing periods, through the heaving of the seedlings, especially of

recent transplants that have not been protected by a proper mulch, out of the soil. We have seen cases of certain conifers where erect plants a foot high have had their bases and roots pushed up several inches above the soil so that they dropped over on the ground. Such plants are apt to be stunted or weakened even when not directly winter injured or killed.

Witches' brooms. These are occasionally seen on young trees that have been injured from some unknown cause other than fungi and have developed abnormal shortened shoots or bunched branches. Specimens of these have been called to our attention on red, white and Scotch pines usually from plantations.

Plums

Anthracnose, *Cylindrosporium Padi* (called by some *C. prunophorae*). While we list this under the same name as that of the imperfect stage on the cultivated cherry, as it was formerly so considered, more recent investigations seem to separate it as a distinct species, called *C. prunophorae,* with a separate asco stage known as *Coccomyces prunophorae.* Our experience with it on *Prunus* sps., however, has been much less than on the cherry and, while common shot-hole injury on the plum may be in part due to it, we do not ordinarily see the fruiting condition on such leaves. Our only herbarium specimen on the plum is one collected by Thaxter years ago with similar specimens on cultivated cherry and wild black cherry leaves. The spores from these three hosts show some differences in the size of the spores, those on the last host especially by their larger size. There are certain other differences claimed for the mature stages on these three hosts that are said to distinguish them as three species. Of course the really important factor is whether these fungi can pass from one host to the others, which is unlikely if they are distinct species. *See* Cherry for further information.

Bacterial spot, *Bacterium Pruni.* While this produces injuries on the leaves, the effect seems to be about the same as on the peach except that injured tissues fall out more readily, thus producing a pronounced shot-hole. It is on the fruit, however, that the chief difference shows. As on the peach, the bacteria develop on the young growing tissues producing a dry rot that seems to stop with their maturity. On the plums these spots are much larger than on the peach and show as purplish-black, sunken, dry spots or areas that are very conspicuous on the green fruit. There is considerable difference in the susceptibility of different varieties to infection. Our complaints have all been on Japanese plums, especially on the Abundance. Because of the damage to the fruit this trouble seems to be more serious on the plum than on the peach.

As in this state there are no plum orchards of any size, we suggest the picking off and destruction of the infected green fruit. Where the infection is bad, however, the use of a late dormant spray with lime-sulphur and dry mix after blossoming might be tried.

Black knot, *Plowrightia morbosa.* This trouble occurs on both the cultivated plums and cherries as well as on several wild species in this state. The knots are swollen places on the stems that break through the bark and on maturity show as thickened, elongated, black galls with close, pimple-like marking indicating the embedded fruiting receptacles of the asco stage of the fungus. These galls are in strong contrast to the smaller, healthy part of the branch on which they occur. With age the outer infected parts die after maturity of the ascospores and the fruiting tissues gradually crumble away though a new crop of galls may start later farther on or even at the edge of the old gall. In time, due to the girdling of the branch, the parts beyond may finally die. On forest trees we have seen old galls, often with imperfect fruiting receptacles, that have reached a size several inches in diameter and over two feet in length but ordinarily on the cultivated trees they rarely exceed an inch in diameter and one to several inches in length. When first breaking through the bark before the black covering develops, there can frequently be found, on the infected rough tissues of the host, a dark-olive growth of the imperfect stage of the Cladosporium type. While other stages have been described, this and the ascostage are the only ones we have recognized.

Years ago we conducted certain spray treatments in a badly infected orchard of sour cherries, which seem to be the ones generally infected, and on these the treat-

ments largely prevented the development of the fruiting stage on the immature knots. The chief remedy, however, was the removal of the infected twigs and branches if the latter were not too large and did not interfere with the shape of the trees. These should be cut *off* some distance below the knots and beyond any indication of evident discoloration of the interior tissues. Cutting *out* the knots from the branches was not usually successful since this often involved the almost complete girdling of the branch and then, if not cut back far enough, there was a subsequent development of a new gall from the mycelium in the infected tissues remaining.

Brown rot, *Monilia cinerea.* On certain varieties this rot is just as bad as on the most susceptible sweet cherries, *q.v.*

Crown gall, *Bacterium tumefaciens.* This has been seen chiefly in nursery stock and more frequently in the past than recently. *See* Rose.

Fire blight, *Bacillus amylovorus.* While this disease has never been recognized by us on this host, it was once reported years ago by Sturgis as very unusual. *See* Pear.

Leaf curl, *Exoascus mirabilis.* This is somewhat similar to the peach leaf curl but seems to involve more extended, general and apparently perennial infection of the young leaves and the terminal shoot rather than the commonly isolated, annual, leaf infections of the peach. It was reported on a variety of Japanese plum in 1895 from New London by Sturgis but has never been found in the state by the writer and has never been reported to him, so it cannot be common here.

Plum pocket, *Exoascus Pruni.* Here is another fungus closely related to the above that apparently confines its infection to the young fruit. This becomes swollen and puffed out as a sort of bladder, since the ovule does not mature into the hard seed, and changes in color from yellow or pinkish to whitish when the fungus matures its ascospores. While it has been reported in various states and was sent to us from Massachusetts, we have no specimen or record of it in this state, although no doubt it has been seen here especially formerly when plums were more commonly grown than now. It apparently is a perennial fungus since it often confines its attack to a single tree that becomes badly infected. These pockets or bladders appear soon after blossoming and at first are round but finally become elongated and sometimes curled and reach one or two inches in length by half an inch in width. They finally turn blackish and fall off the tree in early summer. No treatment so far has been needed here.

Powdery mildew, *Podosphaera Oxyacanthae.* A single specimen and very few records indicate that this is not a common or serious trouble in this state. *See* Cherry.

Shot hole. This injury is common on the leaves, especially of the thinner-leaf varieties. The trouble shows as small, discolored spots in which the tissues separate and then fall out from the surrounding healthy tissues. There are various causes that can produce these shot-like effects, such as sprays, bacteria as in bacterial spot, the anthracnose fungus and apparently other less easily determined ones. In case of the bacterial spot and anthracnose a careful examination of the tissues before they fall out should disclose the cause. When any spray has been used, especially if it has previously shown injury, this is certain to be the cause. Unfavorable environment, producing injuries to the roots, wood or even directly to the leaves, although hard to determine, is likely to result in some shot hole injury. Such may be winter, water, heat or fertilizer injury. Perhaps there are also other fungous or even insect injuries not so well understood that may result in this trouble.

Find the cause and then treat accordingly.

Winter injury. We have had little experience with winter injury on plums. Undoubtedly there has been trouble of this kind in the past, especially when various varieties of Japanese plums were grown in the State. These did not do well for one reason or another and have now largely dropped out of culture. *See* Apple and Peach.

Yellows. Though we have no records and have seen no infected trees in private grounds, we did succeed in producing this disease on a couple of young plum trees in the Station grounds by grafting on them the buds from yellows peach trees. The trouble has been reported elsewhere but apparently the symptoms do not seem to be so definite or the injury so serious or common as on the peach.

Polemonium

Leaf spot, *Septoria Polemonii.* This is an uncommon fungus on cultivated *Polemonium reptans* causing whitish spots, with black fruiting dots, surrounded with a purplish border. Ellis and Martin's *S. polemoniicola* is not distinct from it. Spraying in time should control this trouble where necessary.

Poplar

Anthracnose, *Marssonia Populi* (*M. Castagnei*). There have been several species of this genus reported on various poplars in the United States but whether they are all distinct needs further investigation. The one we report here is the one most commonly seen on the white poplar, *Populus alba,* although we have found it on at least two other poplars, *P. deltoides* and *P. nigra* var. *italica.* This species shows as small, circular, reddish-brown spots from which the embedded fruiting pustules ooze out the hyaline, one-septate spores, somewhat curved and somewhat pointed at one end and rounded at the other. On the white poplar, on account of its hairy lower surface, the spots are most evident on the upper surface from which the spores exude, but on the other species the spots show on both sides with exudation of the spores chiefly on the lower surface. When abundant the fungus may cause some defoliation but apparently no asco stage has been reported on these old fallen leaves.

Ordinarily no spray treatment is necessary but if deemed desirable it should be started on the young leaves.

Crown gall, *Bacterium tumefaciens.* This has been seen as occasional galls on young forest trees and in one case on a yard tree of *Populus alba* where it caused considerable damage to the base of the tree. *See* Rose.

European poplar canker, *Dothichiza populea.* Apparently imported from Europe this disease has been known in the state since 1917 and has been frequently reported by inspectors from various nurseries where infected trees are condemned. The Lombardy Poplar, *Populus nigra* var. *italica,* is the host usually attacked both in the nurseries and in private plantings though we have had one report of it on *P. deltoides* and others on undetermined species. The fungus produces injuries at the base of the trees or their branches especially at the nodes. On young trees or those of smooth bark, these injuries may take the form of definite cankers with evident fruiting bodies of this imperfect fungus, but often these injured areas are not so definite though the branches of the trees may be dead or dying. On some of these we have been able to find some signs of the spores of this fungus and on others not. In such cases it is difficult to determine whether the fungus, winter injury or even insects are the primary cause of the trouble. The fungus gains entrance through wounds or possibly dead branches and, according to Hedgecock, the one who first reported the disease in this country in 1916, infection can apparently also take place through the leaves. The identity of its asco stage, if it has one, is apparently in doubt.

We know of no definite experiments to prevent this trouble by spraying. While thorough pruning may prove helpful when there is little disease present in a tree, if there is much of it we suggest cutting the tree down and burning it.

Leaf curl, *Taphrina aurea.* This disease was not found here until 1931 when it was seen in two of the nurseries on the Lombardy poplar by the inspectors. It shows as round, whitish, thickened spots on the upper surface of the leaf but below develops a yellowish fruiting-surface that is cupped upward. Usually these cups are separated but sometimes they run together; rarely the yellow, cupped surface shows on the upper side of the leaf. The normal size of the cupped spots is about a quarter of an inch in diameter. With age the yellow surface becomes blackish.

The disease is said to carry over on the outer surface of the buds so spraying, as for peach leaf curl, should care for this trouble if needed.

Rusts, *Melampsora Medusae, M. Abictis-canadensis.* These two rusts are not uncommon on the leaves of poplars in this state. They both have their II and III stages on them, the II showing as dusty, yellow outbreaks in the summer and the III in the fall as reddish blisters permanently embedded. The dusty spots of the II stage spread the disease to other poplar leaves. The embedded spores of the III stage germinate on the leaves in the spring and their secondary spores are carried by the wind to the alternate host for their infection. In the first rust, this is the young leaves of the larch; for the second, the young leaves, twigs and cones of the hemlock. *See* these alternate hosts for the I stage described there. Little serious damage is caused to the poplar hosts by these two rusts; the first rust is found chiefly on *Populus deltoides* and the second commonly on *P. tremuloides* and *P. grandidentata.*

It is not likely that spraying will prove profitable in controlling the rusts. One, however, might rake up and burn the old leaves, especially if the alternate hosts are planted near by.

Scab, *Fusicladium radiosum* (*F. tremulae*). No doubt this fungus has long been in the state but we first identified it in 1928 and since then have found it in 1929 and 1931. It occurs here both on the small and large toothed aspens, *Populus tremuloides* and *P. grandidentata.* The leaves are in part or entirely blackened and sometimes even the entire young shoot with its attached immature leaves. At times no growth shows on the dead tissues but, under proper moisture conditions, there appears an evident, sometimes dense, dark, olive-green development of the conidiophores and the one to three septate conidia. We once sent a specimen by mail from Canada that when gathered looked like a bacterial blight but when it arrived in New Haven it showed the evident, conidial growth. We have seen clumps of young aspens seeding in waste places where the disease was very striking in wet seasons and have heard of it as the possible cause of severe damage in Canada at one time. The asco stage belongs, as described by Aderhold, to a *Venturia, V. tremulae,* and has been found here on the dead leaves in the early spring. The fungus is very closely related to the willow scab, *q.v.*

Winter injury. As indicated here under European canker, we have often seen winter injury of Lombardy poplars when planted in yards and streets, especially in the northern part of the state. We believe that between the two troubles the owner will in time lose his trees, so we do not advise planting this species. Even if the trees survive for some time they generally will have plenty of dead branches to spoil their looks.

Poppy

Bacterial leaf spot, *Bacterium papavericola.* This bacterial disease was first found in 1908 in the writer's yard on *Papaver* (probably *P. rhoeas*) and has been seen once since in 1928 in a neighbor's yard, and more recently on *P. orientale* at Newtown. It has only recently been described by others as a species new to science. We found the disease especially prominent on the poppy leaves producing eventually very small, blackish spots scattered over their surface. When wet these spots may become semi-pellucid and at times show exudations of the germs. It is said to occur on the stems and floral parts as well.

Destroy the infected plants of the annual species and plant the new ones next season in a different place. With the perennial species gather up all the rubbish in the fall and spray the ground and the emerging plants in the early spring with Bordeaux.

Potato

Bacterial black leg, *Bacillus phytophthorus.* This disease of potato, *Solanum tuberosum,* was first mentioned from this state in our 1904 Report where it was called questioningly *Bacillus solanacearum.* It was about that time that the black leg was described in Germany and later in the United States under the title given here. It shows as a rot, with the tissues often blackened, at the base of the vines; above these rotted tissues it runs up the vascular bundles and discolors them, as seen in cross sections. The plants are often stunted, the lower leaves yellow and

the upper curled upward; where it is severe the plants die. Often it develops on the young tubers and may show as a blackish discoloration, especially at the edge, under the skin which is easily peeled off. In time, apparently, the soft rot organism may gain entrance. By means of the slightly infected tubers the germ may be introduced in the new fields. Usually in this state the disease in most years merely infects occasional plants scattered through the fields. However, in years very favorable for its development, it may cause noticeable injury.

One should use care in obtaining disease-free tubers or, if suspicious, those treated with formalin or corrosive sublimate. Care in the use of clean knives in cutting the tubers is also desirable so that the germs are not spread from diseased to healthy seed pieces.

Bacterial soft rot, *Bacillus carotovorus.* Almost every potato grower has at times been troubled with the soft, ill smelling rot due to this bacterium. The trouble usually occurs in wet soil or wet years and is often associated with land having considerable humus in it, especially if a green crop has been plowed under late before planting the potatoes. Too large pieces of the tubers used in planting may help develop these bacteria especially if they are not used up in producing the new growth. The trouble, however, is most frequent and serious in the years when the late blight opens the way in the tubers through its dry rot thus allowing this organism to gain entrance and, outstripping the dry rot, to cause the ill-smelling, soft rot. *See* Iris.

Blight, early, *Alternaria Solani.* This disease is so called because it appears before the next disease, usually sometime in June or later. If it were the only fungous disease of the potato we would not need to worry in this state about the crop so far as it was concerned. However, in some years it does a moderate amount of damage. The trouble shows as small, reddish-brown spots on the leaves that usually can be told by the concentric lines of development. The imperfect fungus develops its microscopically conspicuous spores in an inconspicuous way on the surface of these leaf spots. No other stage is yet known. The same fungus has been found here on other solanaceous plants such as egg plant, tomatoes and certain of the wild species.

When necessary spraying with Bordeaux will take care of it if started in time. Where potatoes are regularly sprayed for the late blight this trouble is taken care of at the same time.

Blight, late, *Phytophthora infestans. See* Addenda. (Fig. 48.)

Dry rot, *Fusarium* sp. Every time we look in Seymour's Host Index of The Fungi of North America and see the seventy or more species of Fusarium that have been listed on the potato alone, we hesitate to give a name to any species of this genus. Therefore we fail to give a specific name to the fungus or fungi in this case.

FIGURE 46. Peach scab.

FIGURE 47. Pear scab.

FIGURE 48. Potato late blight.

One of the species of Fusarium is said to cause a wilt of potato vines in the east and also to infect the tubers through blackened invasions of their bundles. This fungus has received the name *Fusarium oxysporum.* We have seen an occasional

field where we suspected a wilt of this nature as partly responsible for the trouble. Likewise we have seen tubers with blackened bundles in which there was the presence of mycelium of a Fusarium and have frequently seen stored tubers whose ends were rotting from the evident, whitish growth of the fungus. We suggest to the growers that all such individual tubers should be rejected for seed. Fusarium or other fungi also usually follow the late blight fungus as well as the bacterial soft rot organism in the infected tubers.

Pythium rot (Leak), *Pythium debaryanum*. The first time we saw this trouble on potatoes, commonly called leak because of its soft wet rot, was in a small way in a field of Irish Cobblers in Milford in 1922. It did not form so ill-smelling or mushy a rot as does the bacterial soft rot. Potatoes grown in the same field the next year showed a greatly increased amount of this trouble, those dug for temporary storage as well as those placed directly on the market soon after digging. We did not see the trouble again until the late fall of 1932 when it was brought to us on Green Mountains that evidently at the end of the season had suffered a slight touch of the late blight. After storage these had developed some rot but after sorting and drying this had stopped and the trouble when seen by us showed on only a few tubers that had a dry, sunken, internal rot without much indication of it on the outside. However, certain reddish-brown sunken places in the skin indicated that it had gained entrance through injuries by the late blight and was responible for a further but different type of rot.

With this trouble spraying as for late blight should prove helpful. If it develops after digging, the tubers should be placed in a cool but dry storage in piles not too deep and sorted over as necessary, especially before sale. Dry liming possibly may help. The sooner the tubers dry out the safer they will be from further rotting.

Rhizoctonia rot, *Rhizoctonia Solani* (*Corticium vagum*). This fungus can easily be recognized by the housewife, when she washes the potatoes for cooking, through the small, black, flattened bodies that adhere closely to the skin despite her efforts to remove them. These are the sclerotia that when the tubers are planted send out the eventually colored mycelium to crawl over the growing plant and gain entrance at some tender place usually at the base of the stem. The reddish-brown cankered areas produced there cause the plants to become dwarfed or develop a sickly growth with yellowed foliage or a terminal rosette of leaves and the tubers are apt to be limited, often directly on the stem just below or even above the ground. Such plants usually occur here scattered through the fields but where seed has not been carefully selected and the season is favorable may cause more severe damage. Occasionally at the base of the stems just above the ground one can find a grayish felt surrounding them. This is the only known fruiting stage, *Corticium vagum*, and belongs to a low form of the Basidiomycetes of which the ordinary toadstools are samples.

Besides injuring the potato this fungus, in its different strains, causes rot here on various parts of a variety of plants as follows: beets, carnation, celery, chrysanthemum, endive, iris, larkspur, lettuce, lily, mignonette, monkshood, pea, radish, rhubard, rutabaga, strawberry, sweet pea, sweet william, tulip; also it causes damping off of a great variety of seedlings, for which *see* spinach in Addenda.

For prevention the grower should secure the best seed potatoes showing little or none of these sclerotia if they have not been treated. Seed treatment is effective but since certified seed potatoes have been introduced this treatment is not so commonly carried on in this state as formerly. If such treatment is desired soak the potatoes for one hour in a barrel of water using four ounces of corrosive sublimate to each thirty gallons.

Scab, *Actinomyces scabies*. This is another of the famous old timers of the potato about which there was confusion as to the cause until Thaxter, the first botanist of this Station, isolated the obscure fungus responsible and produced the disease on tubers through inoculation with cultures, in one case using the germs to trace his initials. We still have on hand, preserved in liquid, one of these cultures and also the inoculated tuber showing the monogram. This low form of fungus is not evident on the infected tubers but its effect is commonly shown through the corky spots etched rather imperfectly on and just beneath the skin and known as scab. Its effect on the tuber itself seems to be usually of little importance but to the growers its presence there is of importance since scabby tubers always sell to a disadvantage. *See* page 157. (Fig. 49.)

The same conditions for control hold as with the preceding fungus except that formalin is also frequently used as a fungicide on the tubers at the same rates. Rotation is also desirable and the use of fresh manure, lime and wood ashes are ordinarily to be avoided since the fungus thrives best in a nearly neutral rather than in an acid soil.

Scurf, *Spondylocladium atrovirens*. This fungus also attacks the tubers but only causes slightly sunken, darker areas on the skin that may cause the tubers to wither somewhat in drying out. The imperfect fungus fruits in an inconspicuous manner on the surface of these injured areas through erect threads bearing whorls of characteristic, multiseptate spores. The fungus was first reported in this country by the writer in 1907 on potatoes grown from a variety of sources on the Station grounds. It has been seen rarely since and never prominently, so it seems to be of little commercial importance here.

Wilt, *Verticillium alboatrum?* We have seen this trouble only rarely and then only on a variety more commonly grown in Maine than here, called Spaulding Rose. One field some years ago in July showed a number of plants somewhat wilted and with rolled foliage but the chief evidence was the canker-like injury on the main roots with a white fungous growth on the same. A second field in August showed at least 10% vines dead or dying prematurely. An examination of the roots showed similar canker and the white growth of the fungus on the main roots. This fungus in both cases also had invaded the fibrovascular system shown by its blackening. Evidently the fungus was carried into the field through infected tubers and the season favored its unusual development. The fungus developed spores of the Verticillium type but no cultures were obtained. This wilt is very similar to the Fusarium wilt already mentioned under dry rot. *See* also Barberry and Maple.

Black heart. This is a trouble that shows in the center usually of large potatoes and sometimes around a central cavity. It seems to result from unfavorable storage conditions as to heat and ventilation. The trouble shows in potatoes shipped into the state, rather than in those raised here, and the manner of heating the cars and the storage barn or the deep piling in storage, cutting off the supply of oxygen, seem to be the unfavorable factors.

Curly dwarf. As applied here curly dwarf of the potato is the occasional plant that remains stunted with short internodes and petioles and curled, rugose, small leaves. It is said to be a virus disease perhaps of the extreme mosaic type since there is some indication of mottling. It is most likely to appear in fields of continuously home-grown seed or those of cheap northern grown seed. It does not seem to be much of a factor in fields grown under the best modern conditions.

Frozen tubers. These may occur with native potatoes stored in pits or cellars not well provided against freezing weather but usually the owner knows the danger of such conditions and realizes the trouble when it appears. It is when potatoes are shipped by cars in freezing weather without proper protection against cold that most of the trouble occurs and complaints are made. Only part of the potatoes may be injured and the purchaser may be in doubt as to the nature and cause of the injury. Such potatoes take on a softer condition when thawed. They often become blackened and the skin may slip off more easily. Of course if the injury is too severe, rot from fungi or bacteria occurs. A sweetish taste usually indicates a frozen potato. Slow thawing rather than quick, lessens the injury if not too severe.

Along this same line is the occasional injury to early potatoes in the fields when late frosts hit the emerging vines. Growers usually want to know what is going to happen to such fields. As a rule the fields seem to pull through in fair shape, especially if the sprouts were not exposed too much and new shoots develop later, which generally happens. However, in the spring of 1932 we saw a few fields in the Ellington potato region where the growers said that the vines had been severely hurt by one of these very late frosts (June 8-9). Apparently the Irish Cobblers were injured more than the Green Mountains possibly because they were more advanced. So far as the freezing of potato vines in the fall is concerned this rarely happens in this state since the vines are usually dead long before killing frosts appear. Likewise the tubers are dug before cold weather injures them.

Hollow heart. This is generally found in the largest tubers and, as indicated by the name, is a somewhat elliptical cavity appearing near the center as if split apart by the unequal growth of the tissues. Apparently that is really what happens. In our opinion the growth of the tubers has reached some size under slow-growth conditions when these are followed, perhaps suddenly, by optimum heat and moisture for fast growth. There then results this internal splitting of the tissues similar to the external cracking of peaches and muskmelons under somewhat similar conditions. Possibly the type of the skin may have something to do with the trouble since we have recorded it chiefly on Dibble's Russet.

Internal brown spots. We have seen this only rarely and then chiefly on foreign varieties, grown for experimental purposes, and apparently of the soggy types poor in starch that are more commonly grown in Europe than here. It sometimes shows on the surface as a somewhat discolored or shrunken skin but the trouble is clearly indicated when the tubers are cut open by the reddish-brown discoloration, usually in spots, scattered within the normally white tissues. These spots frequently have a more watery content than the healthy. Cultures failed to give any indication of fungi or bacteria as the cause of these spots. To our mind the trouble besides being more prominent on certain varieties, is somewhat similar to the spotting of apples, called here Baldwin Spot, and is due to too dry conditions or other unfavorable environment. However, there is the possibility that it may be the result of a virus disease. It should not be confused with the injury called net-necrosis where the injury is in more elongated spots and is largely confined to the fibrovascular system.

Leaf rolls. There are several types of leaf rolls, such as that caused by lice when the leaves roll downward; that of dry weather, sometimes followed by yellowing and death of the vines, if severe or long continued; finally the virus type. This latter is indicated by the upward roll or curling of the leaves and in this respect is not different from the drought type. While we have not studied these last two troubles sufficiently to always tell them apart in their early stages, we usually suggest the drought type when the trouble appears in a normal field in unusually dry weather, especially if it becomes less prominent with later moist weather.

The virus type is indicated, by those who have studied it more thoroughly, not only by the leaves curled in various degrees but usually by their stiffer character and evident tinting at their tips. Often the whole plants are unusually stiff and erect. The crop of tubers is said to be slight, often limited to a few large ones at the top of the stems, apparently due to a necrosis of the phloem tissues which interferes with the conduction of the elaborated food-liquids from the leaves to the underground parts. Net necrosis in the tubers is also claimed to result by some authorities. Lice are the carriers of the virus and the disease appears more severe each year if grown from tubers produced on infected vines.

The problem in this state, where little home-grown seed is used, is to select seed from northern *certified* fields, especially if some interested person has visited them to determine their healthy appearance after full growth.

Lightning injury. This is shown by dead vines, with abnormal plants on their edges, in a circular spot in the field. It has been rarely reported here. *See* Tobacco.

Mosaic. We limit our statements on potato mosaic here to the common mottling of lighter and darker green color of the leaves and agree that it is a virus disease carried by aphids and so is communicated from the diseased to the healthy plants. As to what degree of injury or variability it may assume, we have no fixed opinion or data. In the ordinary field grown from northern seed, we find a varying amount of mosaic on the leaves of the different varieties and in different seasons but apparently not as much or as serious as is claimed in certain other regions especially in the south. Often these mosaic leaves later seem to lose their mottling or it becomes less evident. We have had no experience with a field where the mosaic effects became continuously worse so that we could hold it *entirely* responsible for a very poor harvested crop.

That unrogued crops successively raised here from home-grown seed or grown continuously from tubers of diseased plants will produce poor plants and a poor crop we do not doubt, but to say whether these are the results of mosaic or other virus or constitutional troubles we leave to those more positively informed. This story is well told by Bulletin 160 of the Storrs Agricultural Experiment Station. Our opinion is that the ordinary leaf type of potato mosaic is very similar if not identical with the mosaic of tobacco but perhaps it becomes much more intensified in later generations when continuously propagated through the tubers, which condition does not occur with the tobacco plant. The same precautions should be taken against potato mosaic as are indicated for the virus leaf roll.

Net necrosis. We mean by this those tubers which when cut open show brown or blackish discolorations of the tissues. These are usually elongated or netted and in connection with the vascular system and so most evident near the surface but often they are scattered through the tuber. Some claim that this is a condition found in plants with leaf curl. If so, it is evidence of a virus disease. It is well to reject all tubers showing this condition especially when few in number. However, net-necrosis is also said to be produced by frost injury and such net necrosis tubers will not necessarily show similar trouble in the subsequent crop. We have in mind a season where this injury was rather prevalent in the seed used but which produced, at least in one case, an apparently normal crop with little or no net-necrosis. In this case it looked as though a freezing injury was the cause of the trouble.

Prematuring. This is a general term used by the writer to indicate the premature death of the vines from various causes other than by fungi or virus troubles. During the war period it was most prominent, largely due to unbalanced fertilization, especially when excess of available elements were used to take the place of the lack of potash. Simple potash starvation is revealed by the deeper-green color and bronzed effect of the foliage but in most of these cases the trouble was shown by the lax or weaker strength of the vines, which often dropped over on the ground and finally showed premature yellowing and death of the foliage.

Injury by lice may sometimes cause premature death of the vines but this is usually indicated by their great abundance.

Perhaps the most common or frequent cause is very dry weather, not the hot type that produces tip-burn, but continued dry weather so that the moisture in the soil is largely exhausted. The erect mature plants begin to show yellowed leaves and gradually die prematurely when they should be using the water and food for the vigorous production of the tubers.

With any of these fields it is too late to do anything to lessen the trouble after it is pronounced. Preventive treatments go back to good, typical fertilization, avoidance of fields that dry out too readily, cultivation to conserve moisture as much as possible and watchfulness to see the first signs of lice development so that the necessary treatment may be made early.

Russeted tubers. This minor trouble we have seen on tubers with normally smooth skin that took on the russeted, somewhat aerated effect of certain thick-skinned varieties. It seemed in such cases to be the result of fertilizer injury. Other types of fertilizer troubles are occasionally shown by the injured or stunted vines when too much fertilizer is used, especially when it is too close to the seed pieces when planted or is not properly scattered later in broadcasting.

Spindle sprouts. When the tubers produce long, slender, thin sprouts in the place of the normal, short, thick ones, they are called spindle sprouts. Some claim that these abnormal sprouts come from net-necrosis tubers; others that they sometimes occur on tubers infected with the wilt fungus; then others that they develop on tubers injured from unknown causes, perhaps seasonal. We have only seen this trouble occasionally and have not followed it out in the after effects on the resulting crops, but those who have claim serious injury, as might be expected.

Sun burn. When potatoes are planted too shallow or become uncovered after the tubers are formed, the exposed tubers develop a green color due to the formation in the skin of chlorophyll resulting from the action of the sunlight. Such tubers are rejected partly because of their unusual color and partly on the supposition that they may be poisonous. Pammel in his book on Poisonous Plants makes the following statements: "At certain times the tubers of potatoes are poisonous, especially when green. The writer knows of an instance where the eating of potatoes acted as a poison. The substances produced in the young shoots of the

potatoes are solanin and solanadin . . . . The wilted green stem and leaves are poisonous, containing the alkaloid solanin. The water from boiled potatoes contains a poisonous substance. Some people cannot eat potatoes because poisonous to them."

Tip and Hopper burns. We have here, to the writer's mind, two similar kinds of injury, but different as to origin, which formerly were recognized as one, namely tip burn. This latter trouble has been seen in this state for years and is told by the rolling, wilting and gradual or sudden dying of the mature leaves from the margin inward. It may resemble the old, dried-up leaves of the late blight, being sometimes so mistaken by growers, but it is developed under exactly opposite conditions, namely by dry rather than by wet weather. It is in the unusual and often sudden hot days of July and August that this trouble appears and limits the crop of tubers by the premature death of the vines.

We are not sure we can always tell the tip from hopper burn and both at times may be responsible for the death of the vines. The latter has a similar effect on the mature leaves and in the premature death of the vines. The leaf hoppers apparently when sucking out the plant juices from the veins for food inject a substance in the leaves that possibly may be allied to a virus in effect. This type of trouble is to be suspected when the leaf hoppers are unusually abundant, especially in the absence of unusual hot days, and perhaps can be distinguished by the curled, pinched and somewhat discolored tips of the young foliage on which they may work. One writer states that the tip burn of the larger leaves often shows as more or less scallops of brown tissues, as compared with the V-shaped areas caused by the leaf hoppers.

In either case the chief remedy is obvious—continuous coatings of the leaves with Bordeaux mixture with nicotine sulphate added especially for the hoppers.

Tuber abnormalities. These are of different kinds according to the nature of the causes. When tubers have been formed under dry weather conditions and these are changed to more favorable moist ones, the growth in the tubers may show as knots or protuberances. This also may happen when there is any check to the vines and then new growth or vigor is added to them, especially those of sprayed potatoes. We have already discussed the aerial tubers caused by Rhizoctonia injury.

A different type of tuber abnormality is that due to pressure applied to certain surfaces of the growing tubers, as, for example, flattened surfaces next to stones. We have even seen a case where the tuber grew through a hollow, cut bone and then enlarged by growth on either side so it became permanently embedded. Even more common is pressure exerted by another growing plant, as in the case of quick grass where the slender rootstocks bore directly through the tubers, and of the nut-grass sedge which may push into the tuber and develop a little, nut-like tuber within the potato.

Prairie Dock

Powdery mildew, *Erysiphe cichoracearum.* We have found mature specimens of this mildew on cultivated *Silphium terebinthinaceum.* In the midwest, where species of various rosinweeds grow wild, it is not uncommon. *See* Phlox.

Primrose

Gray mold, *Botrytis cinerea.* This mold has been seen occasionally in low and leaky greenhouses on this and other plants. *See* Geranium.

Leaf blotch, *Ramularia Primulae.* We have seen this disease but once when it developed on small potted plants of *Primula polyantha* that were started in a cold frame and then brought into the greenhouse to be forced. The trouble showed as angular to circular spots of varying size and grayish to reddish-brown in color with a yellowing border of the invaded living tissues. The imperfect conidial stage showed as a rather inconspicuous growth chiefly on the under side of the leaves. While some of the older writers, as Halstead of this country and Cooke of England, give brief notes on this disease, we have not seen any recent work concerning its life history or a remedy.

Presumably spraying with Bordeaux on the young plants should be helpful in preventing the disease from getting much of a start.

Nematode leaf spot, *Cephalobus elongatus.* This eelworm trouble was found sparingly in the leaves of *Primula polyantha* in a flower garden in 1932. The nematodes in these spots were determined by Dr. Steiner of the U. S. Department of Agriculture, as the above species. They caused small, 1-2 mm., discolored, roundish spots in the leaves, differing in this respect from the nematode leaf spots found in begonia and foxglove, *q.v.*

Nematode rootknot, *Heterodera radicicola.* We had a bad case of this on the roots of this plant once in the Station's greenhouse. *See* Cucumber.

Privet

Anthracnose (Bitter rot), *Glomerella cingulata.* This disease has been seen in the nurseries chiefly on imported plants of the common privet, *Ligustrum vulgare,* especially on certain horticultural varieties. It was first found in 1910 in its imperfect stage and some years later in its asco stage on the living plants, so it is given here under the latter name. It produces small cankers in the stems causing them to wilt and die above the injury. These cankers result from the mycelium that first produces the imperfect stage, known on this host as *Gloeosporium cingulatum,* and later the Glomerella stage. However, both are really the same fungus as the bitter rot of apple, *q.v.,* although the imperfect stage received a distinct name because originally it was thought to be a distinct species. As the asco stage was first found on the privet that name is now applied as the mature stage found on all of the different hosts.

For treatment cut out and burn all infected branches and spray with Bordeaux until the disease disappears.

Crown gall, *Bacterium tumefaciens.* This has rarely been reported by nursery inspectors and never as causing any damage. *See* Rose.

Winter injury. California privet, *Ligustrum ovalifolium,* is commonly grown as hedges along our city streets. Ordinarily this passes through the winters without any serious damage. However, during the past thirty years we have seen two years when unusually cold weather below zero killed the plants back to the snow line. Rarely are the bases of the shoots or the roots seriously injured.

In all such cases, the hedge can be renewed by cutting back the stems below the injured parts and fairly close to the ground. In fact old neglected hedges can frequently be trimmed that far back to produce new growth of a more uniform type.

Pumpkin

Downy mildew, *Peronoplasmopara cubensis.* This fungus has rarely been reported on the pumpkin, *Cucurbita pepo,* and then was causing little injury. While we report few diseases on this plant it is probably subject to about the same ones we list here on the squash, *q.v.*

Powdery mildew, *Erysiphe cichoracearum.* The mildew has been seen on this host only in its conidial stage and acting about the same as on the squash. *See* Phlox.

Quince

Bitter rot, *Gloeosporium rufomaculans.* This has been seen only a few times on the fruit of *Cydonia oblonga* and apparently causes very little injury. *See* Apple.

Black rot, *Sphaeropsis malorum.* As on the apple, black rot occurs on the leaves, twigs and fruit of the quince. However, it is on the latter that the chief injury occurs. While the rot may show on isolated spots on the large growing fruit, it seems usually to start at the blossom end or at insect holes and from these most of the injury results.

For this trouble it apparently requires a later spraying, as given for the leaf blight, to further protect the fruit. In addition to the spraying, which is often

impossible on a few individual trees, it is likely that some good will result by keeping the trees trimmed of all dead branches and small twigs that may harbor the spores. *See* Apple.

Brown rot, *Monilia cinerea.* This occurs occasionally on the maturing fruit. *See* Cherry.

Fire blight, *Bacillus amylovorus.* Next to the pear this is apparently the host most frequently and seriously injured in this state. *See* Pear.

Fruit spot, *Phoma pomi.* We have seen this trouble occasionally on the fruit of the quince where it produces small, pinkish or purplish specks or spots. These do not commonly show the fruiting stage but we have seen it in artificial cultures made from them. *See* Apple.

Gray mold, *Botrytis cinerea.* This has been seen occasionally on storage fruit in its fruiting condition or has been isolated from the rotting tissues. In one case of stored fruit, the black sclerotia were found abundantly on the same.

Leaf-fruit blight, *Entomosporium maculatum.* One finds this both on the leaves and fruit of the pear as well as the quince and on both considerable injury may result, here especially on the latter host. The trouble is a fungous rather than a bacterial blight and is so called because it may cause early defoliation of the leaves and serious spotting of the fruit. On the leaves the infected areas show as more or less abundant, small, round, reddish-brown spots with a small, blackish pustule on the upper surface from which the imperfect stage oozes out the peculiar and characteristic spores shaped something like a cross. Somewhat similar but sunken, dark spots with a fruiting stage show, isolated or confluent, on the fruit, often badly disfiguring it and sometimes causing it to crack. Atkinson years ago connected this imperfect fungus with a Discomycete that he called *Fabraea maculata* developed on the dead leaves, but we have not yet collected it in this state. However in 1932 we did find that the old leaves of quinces on the ground were producing fresh spores of the conidial stage.

Thaxter was one of the first to report, in 1890 and again in 1891, very definite results in preventing this trouble by spraying quinces with Bordeaux mixture. He not only prevented premature defoliation but also secured clean fruit by four treatments between May 11th and June 20th.

Rust, fruit-stem, *Roestelia aurantiaca.* We distinguish the rust by this common name since it occurs on the fruit, pedicels and young stems. It is by far our most common quince rust and is further distinguished by the deep-orange color of the spores produced in the white, cluster cups of the I stage. This stage is also produced quite commonly on the fruit and twigs of the hawthorne and shadbush and rarely on the twigs of the apple. It was also once found on the fruit of the Japanese flowering quince, *Cydonia japonica.* The stage on these hosts does not become perennial in the infected tissues as it produces only one crop of the I stage and then the tissues usually die or at least the mycelium does not spread into the uninjured tissues the next year.

The alternate hosts of this rust are the common native cedar and juniper where the mycelium becomes perennial in the somewhat fusiform, swollen branches. These in the spring develop the III stage as the jelly-like exudations common to the rusts on these hosts. The name of this mature or telial stage is known as *Gymnosporangium germinale* (*G. clavipes*). As usual the telial or III spores germinate in these jelly-like sori and their small, secondary spores or sporidia are carried to the alternate rosaceous hosts.

On none of these hosts except the commercial quince does any special attention need to be paid for control. If any infected cedars or junipers are near the orchard trees, it might be well to cut these out. While spraying has not been very successful with the common related apple rust, with this one on the quince the hairy coating on the fruit should allow the spray to adhere better so that a continuous coating of Bordeaux mixture, beginning immediately after blossoming and repeated as necessary until the first of July, should be more effective. Of course the spray should be concentrated chiefly on the fruit rather than on the leaves.

Rusts, leaf, *Roestelia* sps. Besides the preceding rust on the fruit and stems, we occasionally see a pycnial stage showing on the upper side of the quince leaves.

So far the writer has not collected the I or cluster-cup stage on the under side of these infected spots. Thaxter, in his 1891 report to the Station, gives the quince in the state as the aecial host of *Gymnosporangium globosum, G. Nidus-avis* and apparently of *G. clavariaeforme,* but we have no specimens on this host in the herbarium collected by him. Judging from our imperfect knowledge, we would say that the undeveloped form we have run across is *Roestelia globosa.*

In any case these leaf rusts of the quince are now so rare as to cause little injury and so need no attention for control. Rept. **1891**:161–5.

Scab, *Fusicladium* sp. We have never seen this trouble and it is handed down only through a note that Sturgis made in 1893 since no specimen exists in our herbarium. We have no data to show that this trouble has been reported elsewhere on this host and so "regret" that Sturgis did not save a specimen. His statement is as follows: "It is always a matter of regret to be obliged to record either a new locality for a destructive fungus, or the harmful nature of a fungus hitherto considered of little economic importance, yet we have to make this record in the following instance. Early in June a number of quince leaves were sent to us for examination from Tolland. Some of the leaves were completely brown and dead, in others the discoloration had just begun at the tops and was spreading downward. . . . . A careful search revealed the presence of copious fungous threads rising from the surface of the leaf and bearing upon their tips brown, two-celled spores. The fungus resembles the common scab fungus of the apple." Rept. **1893**:79-80.

Radish

Bacterial soft rot, *Bacillus carotovorus.* We have had only one report of this as being rather common on radishes, *Raphanus sativus,* grown at the Station's farm at Mt. Carmel in 1928. *See* Iris.

Black leaf spot, *Alternaria Brassicae.* This is the form we have previously called variety *macrospora.* We are in doubt whether the commonly reported species, as given above by most American writers, includes this or not. If it does not, then the variety to our mind is the parasitic form that causes the trouble to our various cruciferous hosts. It is characterized by the very elongated pedicels to the spores. The other form or species seen on these hosts seems to us to be a saprophyte. On this particular host we have not seen much damage since it has rarely been collected and then on the matured leaves. *See* Cabbage.

Black root rot, *Aphanomyces Raphani.* While this root rot may be more common than indicated here, we have had only one definite report of it which was on radishes grown at the Station farm in 1931. Dr. McCormick, who made a special study of the trouble, reported it was most serious on the Icicle, one of several varieties grown there. It shows as black streaks or areas on the outside of the invaded tissues within, usually for a considerable distance, as a dry rot. It may be confined to a definite area that becomes shrunken and the radish misshapened, or it may invade the whole root. The diseased tissues showed comparatively little of the mycelium and no fruiting stage was present so far as seen. However, from the infected tissues cultures were obtained that formed the characteristic oogonia. The infectious nature of the fungus was shown by inoculating sterilized soil in which seedlings were then grown.

Apparently little has yet been done for the control of this disease. If the land becomes infected, rotation to other crops than radish or beet types should be had. In hot beds or seed frames, sterilization of the soil might prove helpful.

Clubroot, *Plasmodiophora Brassicae.* Clubroot has rarely been reported on this host. Perhaps if the radishes were allowed to go to seed, it might be seen more frequently. *See* Broccoli.

Downy mildew, *Peronospora parasitica.* The fungus has infrequently been found on this host and never causing serious injury. *See* Turnip.

Root rot, *Rhizoctonia Solani.* We have had only one report of this fungus as causing damping-off and later also as root rot of radishes. It is probably more common as the cause of the former than the latter trouble. *See* Potato and Spinach.

White rust, *Albugo candida.* As with the downy mildew, to which it is related, this fungus is rarely seen and is inconspicuous as to its injury on this host. *See* Horseradish.

Growth cracks. This trouble is not uncommon, usually not very serious, on the stem end of the roots, especially of the globular form. *See* Snapdragon.

Spindling. This is a trouble we have seen in hot beds, and perhaps it occurs elsewhere under similar conditions, where radishes in the spring fail to form the normal thickened root. In the hot beds the trouble appears when the temperature apparently is not properly regulated and the radishes develop a very slender hypocotyl two or three inches above the ground without proper root thickening below.

Raspberry

Anthracnose, *Gloeosporium venetum.* This is one of our old troubles of the raspberry and is far more injurious on the blackcap, *Rubus occidentalis,* than on the red, *R. strigosus,* varieties. While it is reported elsewhere on the blackberry and dewberry and no doubt also occurs on them here, it happens we have no collections or notes on these hosts, evidently because of the little injury caused. On the leaves the fungus causes very small, white spots or specks with a purplish border. It is on the stems, however, that by far the most damage occurs. On these the anthracnose shows as larger white spots with similar borders, usually oval in shape, but rarely over a quarter of an inch in length. The spots often run together and give a cankered effect to the young canes which then make a sickly growth or die prematurely. It is on these spots that the imperfect fungus develops a rather inconspicuous mass of spores oozing out from the embedded fruiting threads. While we have not found it, the fungus is also said to develop an asco stage on these cankered spots and this has received the name *Plectodiscella veneta.*

This trouble is hard to control because the spray does not stick readily to the smooth stems. However, with the addition of potassium oleate, we believe this would be more successful. Where troublesome we suggest thorough cutting-out of the diseased and dead canes in the summer after the fruit ripens and again in the spring; then spraying the vines, both before and after the leaves develop, at least two or three times with Bordeaux mixture with this sticker.

Cane blight, *Coniothyrium Fuckelii.* The cane blight sometimes causes considerable injury to the blackcap varieties. It has been found also somewhat on the red raspberries and the blackberries in the state. The trouble shows most seriously when the fungus attacks the base of the canes producing a canker that causes them to wilt and die prematurely. Such cankers can also be found further up on the stems causing a similar wilt and death of the parts above. Often where the canes are trimmed the stem dies back a short distance from the cut and the fungus, gaining entrance there, finally sheds out a circle of brown spores around the embedded, imperfect fruiting bodies. These serve to spread the fungus especially to the blossoms and young berries and through them it sometimes enters into the pedicels and young stems beneath. In such cases one finds the green berries prematurely dried up on the canes. An asco stage has been found by us on the old canes and this, known as *Leptosphaeria Coniothyrium,* was shown by Stewart to be the mature stage.

We have had little experience in fighting this disease. Of course it is desirable to cut out and burn all the dead and diseased canes. Also one should be careful not to spread the disease by the pruning shears which should be cleansed frequently so that the spores do not adhere to them. It might be well, too, to go over the patch early and late in the season to remove and burn any of the infected tips producing spores, cutting them a few inches below the dead tissues. On top of this, spraying with Bordeaux with a sticker might prove helpful although spraying experiments in the past elsewhere did not seem to prove very helpful.

Gray mold, *Botrytis cinerea.* In wet seasons at the time the fruit ripens, this fungus causes considerable injury in rotting the fruit. Little can be done for its control except by close picking to prevent the berries becoming too ripe. *See* Geranium.

Leaf spot, *Septoria Rubi.* This is seen on the leaves and occasionally on the stems. *See* Blackberry.

Powdery mildew, *Sphaerotheca Humuli.* We have found the mildew several times on the leaves of raspberries in its conidial stage only. It has been chiefly on the red varieties and usually causes little harm though in one case it produced a rather heavy coating on the under side of the leaves. *See* Rose.

Rust (leaf), *Pucciniastrum americanum.* Besides the conspicuous orange rust mentioned below, there is an inconspicuous leaf rust that has been found here on the raspberry, apparently preferring the red variety. This rust is very infrequent and does little injury. The II stage shows as small, yellow, dusty outbreaks on the under side of the leaves and microscopically it can be told by the spiny necks of the white peridia that enclose the colored spores. The III stage is even more inconspicuous and is embedded in the reddish-brown injured tissues of the leaf. The I stage is still in doubt though a peridium on the balsam leaves is sometimes seen in the same vicinity.

Rust, orange, *Gymnoconia interstitialis.* In its aecial stage (*Caeoma interstitialis,* in part *C. nitens* of American authors) this long-cycled leaf rust resembles the short-cycled rust reported here on the blackberry. It is difficult to distinguish them except through the germination of their spores. In general the long-cycled form is found on the raspberry and the short-cycled on the blackberry and the dewberry, although we have found a few exceptions in each of these cases. The conspicuous, orange-red outbreaks of the I stage of this long-cycled rust is followed usually on the later developed leaves of the same or other plants by the quite inconspicuous outbreaks of the III stage. This shows on the upper surface of the leaves as very small, yellowish specks in the normal green tissues, and on the under surface are the inconspicuous outbreaks of the two-celled, pedicillate spores.

The treatment is the same as for the orange rust on the blackberry, *q. v.*

Spur blight, *Mycosphaerella rubina.* This trouble shows on the canes usually of the red varieties, at first as a superficial, purplish discoloration at the base of the petioles usually starting at the higher nodes and eventually encircling them. At this stage there is no fruiting body and we recall while with Burrill at Illinois that he tried to isolate some germs from these tissues, thinking it might be a bacterial disease as the term blight might signify. On the old stems in the fall, however, the epidermis becomes whitened and by the next spring the mature, embedded, black, fruiting bodies of the asco stage appear.

Cut out the infected canes and if necessary spray.

Wilt (Blue stem), *Verticillium alboatrum?* This trouble is told by the blue color of the stems of blackcaps and certain leaf characteristics that accompany the wilt. We have only recently isolated the mycelium of the fungus from the infected stems. It is known that there is a similar virus trouble to which term blue stem is also sometimes applied. Some observers have expressed the opinion that our trouble is of this nature. We do know, however, that growers complain of a trouble under this general name, but it needs further investigation on our part to be sure of the common cause.

In 1932, however, we examined a field of blackcaps in which a wilt fungus was present and causing injury and death of some of the vines. Dr. McCormick isolated from the injured plants cultures of a Verticillium as the cause of the trouble. We have not studied this fungus sufficiently to decide whether the species is the same as or distinct from *V. alboatrum* to which it has been reported by some in the past in this country. On the other hand certain investigators in Canada have described a species called *V. ovatum,* on red raspberries; others in England another species, *V. Dahliae,* also on raspberries; still others in western United States a third species, *V. caulophagum,* on blackcaps (possibly the same as *V. Dahliae*)—all as distinct from *V. alboatrum.* So we place our determination on this host as well as on other hosts mentioned in this report, with a question mark for the time being. *See* also Maple and Barberry.

Leaf curl. *See* Addenda.

Mosaic. *See* Addenda.

Winter Injury. In times past we have had more or less complaint of raspberries coming out of the winter in poor condition or at least developing trouble of an unknown cause in the late spring or early summer. Such troubles seem to us to be largely due to winter injury, since they usually follow severe winters or lack of protective snow mulch. In such cases, if injury is not too severe, pull up the weaklings and by good cultivation and fertilization encourage new vigorous growth. We had some complaints of this trouble, especially on red varieties, early in 1932.

Redbud

Leaf spot, *Cercospora cercidicola.* While we found this leaf spot not uncommon years ago in Illinois on the native redbud, here in Connecticut we have seen or heard of it only occasionally in nurseries on *Cercis chinensis.* On this host the infections are apparently somewhat larger, showing as circular, reddish-brown or grayish spots, with a yellow or purplish border, from a quarter to half an inch in diameter. The imperfect fruiting stage shows on the under side as a more or less evident growth of conidia and conidiophores but apparently no asco stage has been reported anywhere. The fungus has not yet become troublesome here. While this is the only fungus that has been found on this host in the state, elsewhere a similar leaf spot caused by Phyllosticta has been reported.

Redtop

Damping-off *Cladochytrium graminis.* On several occasions we have seen or have had sent to us young grass seedlings that have dampened-off much after the manner described under lawn grass. In one case the grass was from a golf course recently seeded in New Britain, and more recently the trouble was seen in a greenhouse at Bristol on young seedlings of redtop, *Agrostis palustris,* grown in flats for exhibition purposes. In these and one or two other cases, we have found on examining the plants the sporangia of a Cladochytrium-like fungus in both the roots and the base of the young leaves, especially in their sheaths. Years ago when studying *Cladochytrium Alismatis,* we remember Farlow telling about finding a similar fungus on grass. After seeing the Cladochytrium in one of the Bristol flats, however, in two especially saved for further examination and two new ones planted with the same soil and seed, we failed to find it again, though the Rhizoctonia, followed by the Pythium and later by the Helminthosporium, caused damping off for some time.

While we have not carried on any experiments with this Cladochytrium it does not seem to be a real cause of damping-off. The sporangia agree in size and shape, though not so mature, with those issued in Rabenhorst's Fungi europaei no. *4177.* We found them only in roots and base of young leaves though the exsiccati specimen was apparently on the mature leaf blades. While there seems to be no full description of *Cladochytrium graminis,* the size of the sporangia and their presence in the roots as given by Büsgen agree with our immature specimens from Bristol. Apparently *C. graminis* has not been reported in the United States, at least Seymour in his Host Index does not list it on any species of Agrostis, but we believe that further study is needed to determine the exact nature of this fungus.

Leaf spot, *Helminthosporium dematioideum.* While this particular species is listed by the U. S. Department of Agriculture from this state we have not determined it ourself. We have, however, collected at least once a species of Helminthosporium on redtop here which presumably may be this species causing a spotting and a premature yellowing of the leaves.

Rust, stem, *Puccinia graminis.* While we have not found this rust very serious in meadows or hay fields, it is a very common one on this host along the roadsides. We have over one hundred and eighty collections on it in our herbarium. *See* Wheat.

Sclerotium blight, *Sclerotium rhizodes.* We have found this trouble on this host only once in a wet meadow in Wethersfield. It was not causing much damage there. The infected plants can be told by the dying of the infected leaves which roll up near their tips. The narrow, whitened tips are in strong contrast to the healthy green parts below. The culms are somewhat shortened and give the impression through these dead tips of being injured by frost. Close examination shows the presence on these leaves of a white mycelium and a few small, purple-black sclerotia about one-fifth of an inch across that are loosely attached to the mycelium on the leaves.

Smut, *Ustilago striaeformis.* This smut shows in a somewhat obscure way on the leaves of the plants, shredding them apart and exposing the black dusty spores. It is not common here in the fields and has been found chiefly in yards and along the roadside. It does comparatively little injury because attacking only occasional plants.

Rhododendron

Leaf spots, *Phyllosticta maxima,* etc. This trouble has been reported a number of times on old leaves of *Rhododendron maximum,* chiefly in nurseries. It produces irregular, unusually large spots with the imperfect stage of the fungus showing as evident, black specks embedded in the upper surface of the leaves. We are still in doubt whether the fungus is an aggressive parasite or merely a weak one that appears after the leaves have been injured from some other cause. However, on *R. carolinianum,* we recently received specimens from Greenwich where the fungus was evidently more aggressive in producing discolored, circular spots in the normal green leaves though the spores (6–10μ) were somewhat smaller than those (10–20μ) given by Ellis and Everhart who described this species originally on *R. maximum.* On this latter host we have found on similar spots the Ascomycete, *Laestadia Rhodorae,* so possibly this may be the perfect stage of this imperfect fungus.

Another fungus, *Pestalozzia Guepini,* that is more evidently saprophytic, has been found on recently imported plants of Rhododendron species in a languishing condition.

Rust, *Pucciniastrum Myrtilli.* This was found very abundant on the leaves of *Rhododendron lutescens* in the Yale Botanical Garden in the fall of 1933. This is apparently a host new to the United States. *See* Azalea.

Leaf scorch. While we call this a leaf scorch it may show early in the spring as a winter injury to the old leaves or it may develop later in the season on both the old and new leaves as a true sun scorch. It shows chiefly at the margins by a more or less extended killing of the tissues inward. *See* Mountain Laurel.

Rhubarb (Pieplant)

Leaf spot, *Ascochyta Rhei.* One can generally find circular, reddish-brown spots about a quarter of an inch in diameter on the leaves of *Rheum rhaponticum.* Usually there is no evident fruiting stage on these spots, so one is left in doubt as to the cause. However, so far, we have found the fruiting stage of the Ascochyta embedded occasionally in them as the apparent cause. In one case, however, we also found a Phyllosticta which is said to cause similar spots. At times the spots become so numerous as to run together in which case the injured tissues are very conspicuous and often fall out. Since the leaf blades are cut off before sale, the injury then shows only through the possibly reduced size of the petioles.

No treatment for control is used here but if desired the old leaves might be removed in the fall as a precautionary measure.

Rot, *Rhizoctonia Solani.* The only other fungus that we have to report on this host is the Rhizoctonia which was found occasionally producing cankers at the base of the petioles next the ground in wet seasons. In the worst cases the leaves turn yellow and die prematurely. *See* Potato.

Rose

Crown gall, *Bacterium tumefaciens. See* Addenda. (Fig. 50.)

Leaf blotch, *Actinonema Rosae. See* Addenda.

Leaf spot, *Cercospora rosicola.* This trouble is a leaf spot, also caused by an imperfect fungus, but it is much less troublesome than the preceding one having

been found only rarely here on cultivated roses though it seems to be more common on wild species. The spots are usually smaller and vary from reddish to grayish-brown with distinct, purplish borders. The conidiophores and spores are borne rather inconspicuously on the upper surface of the leaves but we have not heard of any asco stage associated with the old leaves. So far the trouble is too infrequent to require any treatment here.

Powdery mildews, *Sphaerotheca Humuli, S. pannosa.* The latter of these two mildews seems to be the more common and is generally found in the late spring and summer most vigorously on the climbing roses, especially the Dorothy Perkins. The white mycelium and conidia are more or less evident on the leaves but especially so on the buds and when abundant they cause injury to the blossoms. Later the small, black (when mature) perithecia are more or less evident embedded in the mycelium. The two mildews on this host may not really be distinct but we determine the species found chiefly in greenhouses and on hybrid roses, when the conidial stage only appears during the entire season, to be *S. Humuli.* (Fig. 51.)

FIGURE 49. Potato scab.

FIGURE 50. Rose crown gall.

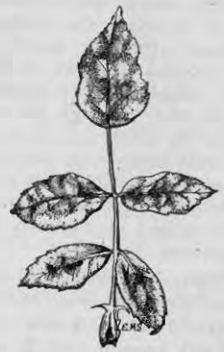


FIGURE 51. Rose powdery mildew.

In the greenhouse cool drafts and excess of moisture are the chief things to be avoided. Many growers paint the pipes with sulphur, or use it sparingly dusted on the leaves, as a method of control. We have suggested spraying outdoor roses with Bordeaux three or four times before blossoming, beginning on the dormant plants or soon after the development of the leaves, since little good is accomplished after the mildew begins to appear.

Rusts, *Phragmidium speciosum, P. subcorticium.* While there have been several rusts determined on various species of roses in this state, so far as the writer is concerned he recognizes only two in this place. Both of these belong to the genus Phragmidium, the III spores of which are pedicillate and have several, horizontal septa. The most common species is the second recognized here. It forms the I stage as conspicuous dusty, orange-yellow outbreaks chiefly on the stems while the II and III stages are found only on the leaves. The II or uredospores show as numerous very small, yellow, dusty outbreaks on the lower side of the leaves and are followed later by the III or telial spores which form similar but less dusty, black sori. Some botanists make different species chiefly on the number of septa of these telial spores.

The first species mentioned here also forms its I stage as evident, yellowish outbreaks on both the stems and the leaves. The second stage is missing while the III stage occurs as prominent, black pustules aggregated on the stems instead of on the leaves.

For control of either of these rusts trim off infected parts of the stems and begin spraying on the dormant plants and continue until blossoming time.

Spot, *Pilobolus crystallinus.* This fungus is not a parasite on flowering plants but grows as a saprophyte on fresh manure sometimes on the greenhouse benches.

We have had only one complaint, where a grower was upset by the sudden appearance of small, black dots, about the size of a pin head, on his roses showing especially prominent on the white petals. These spots were nothing more than the spore cases or sporangia of this fungus that were shot off from their sporangiophores and had stuck to the plants above. This is the usual method of dispersal of this phycomycetous fungus and occurred only as it developed in its prime on the manure for a short period.

Nematode rootknot, *Heterodera radicicola.* We have had only a few complaints of this on the roots of greenhouse roses. *See* Cucumber.

Fasciation. We have seen this once on a rose stem where the flattening was for several feet very pronounced being slightly thinner than the normal stem, from which it extended out from one side, and several times as wide. The stem both below and above this flattening continued its normal growth as to size and shape. *See* Asparagus.

Mosaic. We have noticed rose bushes a few times that showed evident mottling of the leaves but only on a few of the branches. We have never determined whether this was infectious and of the virus type or was due to some local but not evident cause.

Proliferation. This term is used by us when a flower part has changed back into a more or less normal leaf structure. On this particular host we have seen roses with normal petals but at the center changed into a short branch bearing hairy, leaf-like bodies with some indications at their tips of anthers, taking the place of stamens and pistils.

Rutabaga

Bacterial black rot, *Bacterium campestre. See* Addenda.

Black leaf spot, *Alternaria Brassicae.* This disease is found occasionally on this host but apparently is never bad. *See* Cabbage.

Clubroot, *Plasmodiophora Brassicae.* It has been found a few times on this host but apparently is not as common as on the white turnip. *See* Broccoli.

Downy mildew, *Peronospora parasitica.* While never serious the downy mildew is occasionally seen on the leaves of this host. *See* Turnip.

Powdery mildew, *Erysiphe Polygoni.* Like the preceding mildew, this powdery one is occasionally seen on the leaves, in its conidial stage only, but causing little injury. *See* Clover.

Root rot, *Phoma Napobrassicae.* This trouble has been reported to the writer only once and then after the rutabagas were dug and in storage where the rot chiefly occurred. We did not have, therefore, a chance to determine if the fungus also occurred on the leaves. On the roots it caused a conspicuous, dry, sunken, dark rot in separate spots with the black, embedded fruiting pycnia becoming quite evident when the infected roots were kept moist. While this host is also a crucifer and the fungus belongs to the same genus as the black leg of cabbage and broccoli, it is possible that these two fungi are distinct species, as named here, since this one seems to have pinkish rather than colorless spores. Some writers, however, claim that they are identical. *See* Broccoli.

Scab, *Actinomyces scabies.* While we have not listed the scab on this host, Sturgis in 1896 reported from 17 to 40 per cent infection on different rows of rutabaga planted in infected soil. Rept. **1896**:266.

Rye

Ergot, *Claviceps purpurea.* This fungus shows as an evident, purplish, cylindrical, often somewhat curved, sclerotium projecting out of the spikes of the infected rye, *Secale cereale.* Rarely more than one is seen in the spike. These sclerotia develop a characteristic Ascomycete after passing the winter on the ground but this is rarely seen. Infection of the young blossoms and seeds takes place from the germination of this stage and from these develop the large sclerotia about one inch long. These sclerotia are poisonous when eaten by animals and may cause

abortion and other serious troubles. Fortunately they are not common in most rye fields but are more likely to be found at their edges or on escaped seedlings. (Fig. 52.)

Besides this ergot on rye we have in the herbarium collections, made in the state over a considerable period, on different grasses and one species on Carex. These vary considerably in the size of the sclerotia, mostly shorter or relatively thinner, but one, on Bromus, reaches the length and robustness of that on rye. Different names have already been applied to that on the Carex and to the much smaller and narrower form on Dactylis and Phleum, *q.v.* under Timothy. The other hosts, both wild and cultivated, include Agropyron, Bromus, Festuca, Lolium and Phalaris (this latter looks like *C. microcephala*) and to these the name *C. purpurea* has already been used by different botanists in the past. Possibly some may merit distinct specific names after careful study.

Powdery mildew, *Erysiphe graminis.* The mildew sometimes occurs with the rust on the leaves of this host, the former producing usually a heavy, dirty-white coating in which are embedded the more or less hidden perithecia. It seems to be more frequent on the rye than on other grasses though it is also common on *Agropyron repens* as a weed. It has also been found here on cultivated barley, wheat and blue grass. On the last host it is whiter and less dense and so far no perithecia have been found.

As it is not usually common on any of its hosts, except in wet years, nothing is done for control.

Rust, leaf, *Puccinia dispersa* (*P. rubigo-vera*). This rust is much more common than the next in this state though in most places it does less damage. It appears in late spring in its II or uredo stage as small, dusty, yellow pustules (more or less abundantly) on the leaves. In walking through a field when this stage is in its prime one's pant-legs are discolored by the spores. Later in the season, the telial stage is produced on the same leaves as darker, more permanently embedded spores. The I stage is said to occur on certain hosts of the Borage family but this has never been found here. No control methods are used in the state.

Rust, stem, *Puccinia graminis.* This occurs somewhat in the fields in favorable seasons but is much less injurious than in the western grain states. *See* Wheat.

Scab, *Fusarium culmorum.* On the heads of rye and wheat we occasionally find a pinkish exudation of the spores of a Fusarium for which we use the above specific name. Very little damage seems to occur here though where these grains are grown more extensively considerable damage is claimed for this or a similar species. The status of Fusarium is so complicated, and we have made no cultures of this particular species, therefore we cannot state whether or not this one is connected with the asco stage known here as *Gibberella Saubinetii.* *See* Corn.

Smut, *Urocystis occulta.* This smut has been found a few times in the state on the leaves and stems of rye but only once have we seen it prominent. The maturity of the fungus spreads apart the infected tissues and exposes the dusty, black spores over their surface. No treatment is necessary because of the infrequent and minor injury caused.

Salsify (Oyster Plant)

Bacterial soft rot, *Bacillus carotovorus.* This trouble has been called to our attention only once and then on plants of *Tragopogon porrifolius* stored in pits for winter use. The bacteria worked down through the cut leaf tops into the root tissues causing a soft, black rot of the interior tissues only. *See* Iris. (Fig. 53.)

Powdery mildew, *Erysiphe cichoracearum.* We have rarely found this mildew, in its conidial stage only, and then in an inconspicuous way on this host. *See* Phlox.

White rust, *Albugo Tragopogonis.* Occasionally the writer has found this member of the downy mildew family on this host in market gardens in the state. The white blisters, containing the conidia, are conspicuous on the leaves and, on rupturing, these temporary spores spread the disease. Late in the season we have found the larger, round, thick-walled winter spores hidden within the tissues.

The trouble is not usually prominent and so no preventive treatment is required. If trouble occurs rotation should limit it.

Sea Lavender

Leaf spot, *Alternaria* sp. At a nursery in Cheshire in August, 1932, we found certain leaves of *Limonium latifolium* showing evident, reddish-brown, round spots, chiefly one-quarter to half an inch in diameter, on the living leaves. The only fruiting stage seen on them was an Alternaria and as the spots showed the somewhat concentric markings, often seen on Alternaria leaf spots, it looked as if this was the cause. However, so far as we have learned, no Alternaria species has yet been reported as injuring a Limonium, so further study of the trouble is needed.

Rust, *Uromyces Limonii.* At the same time as in the above nursery we found this rust. We had collected it before on *Limonium carolinianum,* along the sea shore in both Connecticut and Nova Scotia, in all three stages. This was the first time we had seen it on cultivated plants and *L. latifolium* is apparently a host new to North America since neither Seymour nor Arthur report it on this species.

This rust was spreading in the leaves of certain of the plants, showing chiefly on the lower surface as dusty, reddish-brown, subcircular pustules mostly of the II stage. In the middle of October looking at these plants again, we found the III stage present in great abundance on the old dead, flower stalks. These pustules were a little darker and less powdery than those of the II stage. We did not see the I stage probably because we did not examine the plants early enough. We have found this stage in June on the wild species where it formed small, circular clusters, about a quarter of an inch in diameter, of the toothed cups of the aecia on the blades and occasionally on the midribs of the leaves.

As this rust has all of its stages on the same host it may prove troublesome in flower gardens, so the owners should aim to secure plants free from the trouble in the first place. If it does appear destroy the first infected leaves and, if this does not control it, in the fall carefully clean up all the old leaves and stems and burn them. In the spring start spraying the ground and the plants with Bordeaux as soon as the first leaves appear, watching for and destroying any leaves on which the I stage may appear.

Stem fungus, *Phoma* sp. We also had complaint in July, 1932, of *Limonium latifolium* dying in a small perennial garden at Plainville. So far as we could find there was no evident fungus on the living tissue that we could blame for the trouble. On the other hand dry weather, following possible recent transplanting, might have been responsible. On the stems and somewhat on the leaves of the prematurely dead plants, however, there had developed an abundance of the small, black, embedded pustules of a Phoma fungus that possibly might have been the cause of death rather than have developed later as a saprophyte on the dead tissues.

Sesame

Leaf spot, *Cercospora Sesami.* The leaf spot was found by the writer on a few of these herbs, grown commonly for food or oil from the seeds, on the Experiment Station grounds at New Haven in September in 1903. This was shortly before the fungus was first described from Dutch East Africa by Zimmermann in 1904. The trouble agrees fairly well with the description published by Saccardo (Sacc. Syll. Fung. **18**:595) in 1906 but it was only recently that we determined our specimens other than as a species of Cercospora! The fungus has been reported before in this country since Seymour lists it on *Sesamum orientale.* Bailey gives *S. indicum,* the host on which we reported it, as a synonym of this species.

The spots are light to dark brown, angular to somewhat circular and from 2 to 10 mm. in length according to their age. The fruiting stage shows on the upper surfaces of the leaves but on our dried specimens is not very evident because there remains visible only the inconspicuous, dark bundles of the external conidiophores. Because of their fragile nature only a few of the septate, hyaline, elongated spores remain unbroken but the few whole ones that we could measure went from 90 to

110μ in length by 3 to 4μ in width and so agree very well with the original description.

Shadbush (Service Berry)

Rusts, *Roestelia aurantiaca, R. Ellisii, R. Nidus-avis, R. lacerata x.* Not uncommonly on the native and occasionally on the cultivated plants of Amelanchier, the aecial stages of certain rusts have been found and listed from this state. The first one, *R. aurantiaca,* we have frequently found on the fruit and occasionally on the stems and this has its III stage, *Gymnosporangium germinale,* here on the cedar and juniper (see Quince and Cedar). The other three species are not represented by identified specimens in the herbarium for some reason and we are doubtful about the characteristics by which they can be identified. Thaxter, however, listed all three from the state and really described one from here. Their relationships are as follows: *Roestelia Ellisii* occurs on the leaves and has for its III stage, *G. Botryapites,* causing on the white or swamp cedar fusiform swellings; *R. Nidus-avis* occurs on the fruit and stems on hypertrophied areas and has for its III stage, *G. Nidus-avis,* causing witch's brooms on the red cedar; *R. lacerata x* occurs on the hypertrophied areas on the leaves, stems and fruit and has for its III stage *G. clavariaeforme,* here on the juniper.

Shade Trees

Fungous diseases. Under certain trees, we have briefly mentioned here definite wood rotting fungi that are more or less parasitic on these trees in their living condition. These include among others such general species as *Fomes applanatus, F. connatus, F. igniarius, Polyporus sulphureus, Pleurotus ostreatus, P. sapidus, Armillaria mellea,* etc. Besides these there are various leaf and stem fungi that are more specific in the hosts they attack but which cannot be mentioned even by name here.

Injuries. There are many environmental factors that cause injury to shade trees and especially to those planted on our streets; see list of these named under Injuries in the general statement at the beginning of this bulletin. Most of these at one time or another we have had called to our attention as causing injury to shade trees but we cannot go into details here. They are factors, however, that one needs to take into consideration when the cause is not shown to be a parasite.

Scorch. While we discuss elsewhere under special hosts troubles of this general nature, we have never seen as much injury to a variety of shade trees as that which occurred in the fall of 1933, especially following the tropical storm of August 25th. It was most severe and widespread on the trees and shrubs along the shore, especially in places where they were exposed to the salt spray that came from the Sound. It was seen inland, however, as far north as Danbury showing on the exposed southeastern side of the trees by the premature death or scorching of the leaves on that side as compared with the healthy leaves on the opposite side. Various species of trees showed its effect but it was most noticeable on the oaks, maples and elms.

Snapdragon

Anthracnose, *Colletotrichum Antirrhini.* Sometimes this disease becomes prominent on the stems and leaves of the snapdragon, *Antirrhinum majus.* It forms elliptical, light-colored (often sunken on the stems) spots with a purplish border and these vary from quite small to a quarter of an inch in length or even somewhat merging into more extended areas. The rather inconspicuous, imperfect stage oozes out the spores from the blackish, fruiting groups. Apparently no asco stage has yet been found.

The grower should make cuttings only from healthy plants. Whether the disease appears in the garden or the greenhouse, one should destroy the worst infected plants, clean up all rubbish, pick off the lower worst infected leaves, spray with Bordeaux with a potassium-oleate sticker and, if possible, cut down watering on the leaves.

Minor drop rot, *Sclerotinia minor.* While very similar to the drop rot (discussed under lettuce, *q.v.*) we have termed the trouble discussed here as the minor drop rot. This is because it is not only less common but also because the sclerotia are much smaller in size, being about ½ to 2 mm. in length. It acts like the other drop rot in producing black sclerotia on the white mycelium that rots off the plants. These sclerotia, after passing over the winter in the ground, may develop a stalked Discomycete similar to the other species but which is much smaller, according to Jagger who described it as a new species. Under certain conditions, he also found that this fungus produced micro conidia. Besides finding these sclerotia some years ago damping-off tobacco seedlings in a seed bed, it recently was found rotting the base of stems of snapdragons in a greenhouse, from which cultures were isolated producing these small sclerotia. We have never seen or tried to develop the Sclerotinia stage from these.

The control treatment should be the same as described under lettuce.

Rust, *Puccinia Antirrhini.* Here we have a rust that in recent years has become more common in greenhouses than when we first saw it in 1915. The rust develops grouped blisters on the leaves and stems that on rupturing disclose the dusty, red-dish-brown spores of the II stage. This is the only stage that shows on our specimens, collected chiefly in greenhouses. Outdoors late in the season, the darker sori of the III stage is said to occasionally occur. The I stage is unknown. There is considerable difference in the susceptibility of different varieties to the rust, the white ones being, apparently, the most susceptible.

Doran of the Massachusetts Station was successful in controlling this rust by the use of fine sulphur on the plants about every two or three weeks, keeping the night temperature at these times up to 60–70° F. for a couple of days to make the sulphur more active.

Stem rot, *Phyllosticta Antirrhini.* This disease produces somewhat similar spots on the leaves and stems as the anthracnose but they are larger, usually darker and the black fruiting bodies are embedded, more evident and numerous. The chief injury is usually on the stems since the fungus not only attacks the younger stems

FIGURE 52. Rye ergot.

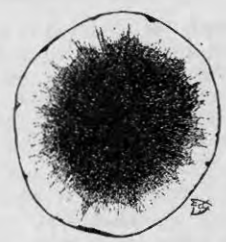


FIGURE 53. Salsify bacterial soft rot.

FIGURE 54. Snapdragon rootknot.

but often also the large main stem. At one time it was called a Phoma, chiefly because when this type occurs on the stem it is so-called but when on the leaves it is placed under the genus Phyllosticta and this species happens to be on both. There is no known asco stage yet identified with it. We have seen the disease a few times and have had one complaint where it was serious in a greenhouse.

The treatment should be the same as for the anthracnose, previously described on this host.

Wilt, *Verticillium alboatrum?* Late in February, 1933, a greenhouse grower of Southington came to the Station with flowering snapdragon plants that showed

a wilting, browning and finally a drying up of the leaves. There was no external evidence on them of any fungus as the cause of the trouble. On cutting across the stems, however, there was found the mycelium of a fungus that was growing in the fibrovascular bundles and evidently the cause of the wilt. Dr. McCormick isolated from the infected stem a Verticillium similar to those she has obtained from other hosts that have suffered from wilt diseases and to which some have ascribed the fungus given here as the cause.

Since this fungus lives in the soil in greenhouses, in a case like this, the dirt should be removed or sterilized, especially if the same crop is to be grown again in it.

Nematode rootknot, *Heterodera radicicola.* Snapdragon is one of the several greenhouse hosts upon which this trouble has been found. *See* Cucumber. (Fig. 54.)

Growth cracks. We learned indirectly from the owner of a greenhouse, after the holidays early in 1933, that he had suffered loss from certain varieties of snapdragon, especially Afterglow, on account of the stems showing small cross-cracks just below some of the leaves in the upper part of the flower stalks. These were not conspicuous but when the blossoms were sold to a wholesaler the grower received complaint because of the considerable number of flowers that broke off at these cracks.

The trouble appears similar to growth cracks reported here on vegetables and fruits outdoors in certain seasons and where different varieties vary considerably. These troubles seem to be due to sudden changes to the rapidly growing tissues and are regulated in part by variations in water, heat, sunlight and food available to the same. The cracks are small, something like oedema and tumescences resulting from an upset of the normal conditions, but take the form of splitting rather than abnormal, pustular growths. In this bulletin we mention growth cracks under the following additional hosts: cabbage, muskmelon, onion, peach, radish, strawberry, tomato and turnip.

We ordinarily think of the trouble on outdoor plants as coming from sudden changes from moderately dry and warm to wet or muggy weather, or possibly the reverse, where the growth of young tissues has been stimulated by extra water and plant food. In this greenhouse there was evidently plenty of food for vigorous growth but the owner claimed he had kept the plants fairly dry. Nevertheless unnoticed changes in the temperature between day and night heating or the presence of muggy or cloudy weather could have had influence in producing the trouble.

Snowberry (also Coralberry)

Fruit rot, *Alternaria* sp. Recently we observed in the fall the fruit of the snowberry, *Symphoricarpos racemosus,* turning brown and dying prematurely through a dry rot. While no fruiting stage developed on the berries, cultures made from their tissues uniformly produced an Alternaria as the cause. The berries, of course, are made much less attractive by this premature rotting which was probably induced by wet weather and a common saprophytic species of Alternaria.

Gray mold, *Botrytis cinerea.* This rotting of the young leaves and twigs has been seen rarely in the spring as a result of wet weather. *See* Geranium.

Powdery mildew, *Microsphaera Symphoricarpi.* This mildew is also known under the name of *M. diffusa* as given by Salmon. We retain the name as given by Howe. Burrill used this name in Ellis and Everhart's N. A. Pyrenomycetes in 1892 where we helped him in the identification of the various species of this group. The microscopic appearance of this powdery mildew is much the same as described here for other species but it seems to merit distinction from *M. diffusa,* found only on the pulse family, through its microscopic features as well as its appearance on these hosts of a different family. It is found occasionally in this state both on the wild and cultivated species of Symphoricarpos (chiefly *S. racemosus* and *S. vulgaris*) but causes little injury other than marring the looks of the foliage.

Sorghum (also Broomcorn)

Anthracnose, *Colletotrichum graminicolum.* This fungus has been found here once on the sugar sorghum which is rarely grown, except for curiosity as occasionally at the Station farm. It has also been reported here under the name of *C. lincola.* We have also collected it a few times on Sudan grass, (*Holcus sorghum sudanensis*) where it forms numerous, purplish, elliptical spots usually 2-3 mm. in length that later develop a light brown center but apparently rarely a fruiting stage. *See* Corn upon which it also occurs.

Bacterial sheath blight, *Bacterium Andropogoni* (*Bacillus Sorghi*?). This disease is seen most commonly on the inside of the leaf sheaths where it develops reddish to dark-purple discolorations of the tissues. It apparently was described by Burrill years ago in Illinois as also causing injury to other parts of the plants and *Bacillus Sorghi* was named as the possible cause. We have seen this trouble chiefly on the sheaths, commonly in Illinois but rarely here in Connecticut, on sugar sorghum and while bacteria are apparently associated with the injured tissues, we are doubtful whether they are entirely the cause since lice are also possible factors, at least as infecting agents. Of course water running down between the stalk and the tight leaf sheaths also aids saprophytic bacteria to develop under these conditions on the injured tissues. Very similar injury is also seen in the sheaths of corn, *q. v.,* under the same conditions, to which Burrill apparently assigned another bacterium as the probable cause.

Smut, *Sphacelotheca Sorghi.* The smut occurs on the panicles as oblong, evident projections taking the place of most of the seeds and these are covered with a false membrane of fungous tissue that on rupture discloses the dusty, dark mass of spores of the fungus. It has been found here on broomcorn (*Holcus sorghum technicus*), sugar sorghum (*H. sorghum saccharatus*), red Kaffir corn (*H. sorghum caffrorum*). It can be prevented by seed treatment. The smut gains entrance only through the germinating seed and makes its first visible appearance weeks later in the maturing blossoms, having traveled upward in the stem through its hidden mycelium.

Soybean

Bacterial spot, *Bacterium glycineum.* In 1916 (Rept. 1915:444.) we reported a bacterial disease of soybeans (*Soja max* formerly called *Glycine hispida*) under Bacillus sp., seen the preceding season at the Station farm on a number of different varieties. This injury showed as conspicuous but small, chiefly 1-2 mm., dark-brown, angular spots, scattered or occasionally aggregated more or less abundantly, over the leaves. We made no bacterial cultures but presumed the disease was similar to the common bacterial disease seen on the near-by wax and lima beans. So many bacterial diseases have been described on soybeans that one is confused whether or not they are all distinct. Elliott recently cited our report under the bacterial disease called *B. glycineum* but we are inclined to believe that, in one specimen, there was also present the trouble described by Hedges as *B. Phaseoli* var. *sojense* as this showed a yellow halo. *See* statements on Lima and String beans. (Fig. 55.)

Gray mold, *Botrytis cinerea.* In October, 1926, we saw a number of plants at the Station farm, the green leaves of which had been partly killed and this fungus was fruiting on them. *See* Geranium.

Crinkling chlorosis. Mosaic has been reported on this host by others. In the case we report, the irregularly yellowed leaves also showed an evident crinkling of the tissues around the larger veins apparently not due to the variety since it appeared on those normally smooth. Some of the leaves showed the yellow mottling without this crinkling. It was not determined whether this injury was due to seasonal conditions or was of the nature of a virus trouble.

Spearmint

Rust, *Puccinia Menthae.* This was seen twice on *Mentha spicata* in a mint garden, once recently where it evidently carried over on the old stems in the I stage. It has been frequently found on wild plants of this same species. The only other cultivated plants on which we report it here are apple mint, beebalms and peppermint, *q.v.*

Speedwell

Crown rot, *Sclerotium Delphinii.* In one of the nurseries of the state dealing with rockgarden plants, a creeping speedwell (*Veronica filiformis*) showed this trouble more than any of the other plants, though it is also found there on *Iris cristata* and Delphiniums. *See* Larkspur.

Powdery mildew, *Sphaerotheca Castagnei.* We have found this mildew rarely on Veronica. On *Veronica longifolia* var. *subsessilis* it was found in a nursery late in 1932 for the first time in this state. It produced a moderate amount of the white mycelium and conidia on the upper surfaces of the leaves but the perithecia of the mature stage were conspicuous chiefly on the lower surfaces as small, round, reddish-black, superficial bodies. The same fungus has also been found here on wild specimens of *V. virginica,* commonly called Culver's Physic, which is now often cultivated in our gardens. The only other host given here is Dandelion, *q. v.* Salmon lists this mildew under *S. Humuli* var. *fuliginea* instead of as given by us.

Where needed, early spraying with lime and sulphur should control this trouble if begun early enough.

Spinach

Anthracnose, *Colletotrichum Spinaciae.* While this disease of *Spinacia oleracea* has not been seen here as frequently as the leaf mold later described, it seems to be a more aggressive parasite in the field in some regions. It forms spots on the leaves very similar to the leaf mold but the fruiting stage is not so dense, showing more as very small, clustered groups of the blackish setae while the light colored spores are hidden beneath them. There is no other than this imperfect stage, so far as is known.

As spraying, or even dusting, is not a very practical method of control for spinach troubles about the only partial preventive for this and other diseases of this host is consistent yearly rotation.

Damping-off, *Pythium debaryanum, Rhizoctonia Solani. See* Addenda.

Downy mildew, *Peronospora Spinaciae. See* Addenda.

Leaf mold, *Heterosporium variabile.* We have seen this trouble chiefly on the leaves of spinach in the market, both native and imported, but also occasionally in the fields. It seems to be a sort of semi-parasite since it occurs chiefly on the older outer leaves. It forms yellowish and then whitish, circular spots about a quarter of an inch in diameter with eventually a more or less dense, black growth of the conidiophores and spores of the imperfect fungus. It apparently has no asco stage and its development is favored by cold, wet weather and unfavorable conditions after shipment of the crop.

Yellowing, etc. We have heard, off and on, of a number of complaints about spinach doing poorly, the chief characteristic besides poor growth being the yellowing of the foliage. Some of this may have been due to the downy mildew which produces yellow spots on the upper surface of the leaves but apparently there are other less evident factors that have caused complaints. We have not personally come in contact with many fields where there has been such injury but we suspect that in some cases the trouble has been due to abnormal seasonal conditions together with fertilization not adapted to the best growth of the spinach. In fact our soils specialist, Mr. Morgan, believes that spinach requires plenty of lime in the soil to do well and it is often the lack of it in the fields that produces the sickly, yellowish plants with poorly developed, reddish-brown roots. There is a chance that some of the trouble may be the yellows or mosaic, said to be a virus disease that occurs in some of the large market gardens of Virginia, but we have failed to identify it here so far.

Spiraea

Leaf spot, *Septoria Ulmariae.* We found this fungus only once in a nursery on plants of *Spiraea Ulmaria* (now called *Filipendula Ulmaria*), where it produced numerous, small, about 1 mm. in diameter, reddish-brown spots on the leaves.

Under the lens these spots showed a narrow border with a somewhat lighter center in which the fruiting stage appeared as embedded, semi-transparent specks.

Powdery mildew, *Sphaerotheca Humuli.* Specimens of this mildew were sent from Thompson in August, 1922, on stems and leaves of cultivated *Spiraea opulifolia* var. *aurea* (now called Physocarpus). While not so evident on the stems it was very striking on the leaves because of the mycelium and the abundance of the mature perithecia which are not so common with this mildew on most of its hosts. *See* Rose.

Fasciation. This trouble was found once in a private garden in Litchfield showing a moderately flattened stem with normal, small, flowering branches along the same but as the stem was broken off below the tip its character there does not show in our specimen. *See* Asparagus.

Spruce

Rust, *Peridermium consimile.* This rust has never been found here on any of the cultivated spruces but only on the swamp species of *Picea mariana.* The young leaves of the latter in the spring develop a yellowish color, often very conspicuous, and soon produce the small, dark, pycnial receptacles, of undetermined function, and early in the summer the I stage on the same leaves. This I or aecial stage shows as one to several, white, oblong projections, less than an eighth of an inch high and about half as wide, that extend in a row on the leaves. They soon rupture from the top and disclose the orange, dusty spores that spread the rust to the leaves of the leather-leaf plant that develops also in these swamps. On this host it develops the II and III stages, known under the name of *Melampsoropsis Cassandrae,* as made out first by the writer.

There is little likelihood that the rust will ever be serious on any of the cultivated spruce trees away from swamps.

Witch's broom, *Arceuthobium pusillum.* Occasionally on these same swamp spruces there is found a witch's broom effect of the branches that is due to the presence of a parasite, not of the fungous type but belonging to the true flowering plants. This plant, often less than an inch tall, with rudimentary, scale-like leaves and very minute simple flowers in their axils, gets its food, like the fungus, direct from its host, and as a result of the invasion of the tissues produces this injurious effect.

Cankers. Occasionally we have had called to our attention, from the region of Stamford, injuries to the blue spruce for which we could find no definite cause. Certain branches showed rather indefinite cankers with some resinous exudations, and the foliage sometimes turned yellow and the branch finally died. There was seen no fruiting stage of a fungus and no evident injury that could be traced to insects. In some of the cultures obtained from the injured tissues a Phomopsis appeared, but we are not sure that this had anything to do with the trouble. It was difficult to see, also, how, since only isolated branches were affected, winter injury could have been the cause.

Frost or Sun scorch. We have had several cases of trouble to spruces, especially in 1933, where some of the leaves and stems, particularly of the new growth, died suddenly on certain plants where no insect or fungus was present as a possible cause. Apparently sun scorch or a late frost was responsible for the trouble in such cases on the young plants.

Squash

Anthracnose, *Colletotrichum lagenarium.* This has been found occasionally on both winter and summer squashes and is usually most injurious to the leaves. In the summer of 1932, however, we found it particularly bad on the fruit of Michigan summer squash. Very often the softer interior tissues were partially rotted before the trouble appeared on the outside, the first evidence being a leak of water from the interior. Growers who sold such apparently healthy squashes often had them returned with complaints. One grower had finally to use his crop merely for seed purposes on this account as he could not tell the healthy from the injured fruit. With maturity of the squash the fungus usually produced its fruiting stage

as embedded, black, bodies concentrically arranged on the hard rinds. *See* Watermelon.

Bacterial leaf spot, *Bacterium lachrymans.* It was seen in July, 1928, causing injury to the leaves of Vermont Hubbard squash, *Cucurbita maxima,* at the Station farm. The small, angular spots on the leaves often ran together into large areas. *See* Cucumber.

Bacterial soft rot, *Bacillus carotovorus.* This is sometimes found on the fruit in the field in wet weather, especially on the thinner skin varieties as the summer crooknecks, *Cucurbita pepo condensa. See* Iris.

Bacterial wilt, *Bacillus tracheiphilus.* In certain seasons, this is one of our most conspicuous troubles of cultivated plants of the gourd family. It has been found causing much damage to cucumbers, muskmelons and squash and probably occurs occasionally on other less frequently cultivated plants of this family. The injury is caused by bacteria that eventually clog or injure the fibrovascular bundles in the stems and leaves, thus cutting off the water supply to the leaves which wilt and often dry up while still partially green. In time the whole plant usually dies. The bacteria are accidentally inoculated into the plants through injuries by the striped cucumber beetles. When bad the injury can be told by cutting across the stem, sometimes the leaves, and observing the condition of the exudation from the bundles. If this is sticky and milky colored, there is no doubt of the presence of abundance of bacteria as the cause of the trouble. (Fig. 56.)

FIGURE 55. Soybean bacterial leaf spot.

FIGURE 56. Squash bacterial wilt.

FIGURE 57. Strawberry leaf spot.

It is difficult in favorable seasons to prevent this bacterial wilt. Covering the plants with netting and spraying with lead arsenate to prevent infection by the cucumber beetles have been only partially successful. We believe in this state the easiest and best method is to plant plenty of seed and after the plants appear to pull up and destroy all the poor and sickly ones. Leave one or two extra in the hills after the plants begin to run in fair shape to be removed later if necessary. When the vines reach fair size, there seems to be little increase of the wilt, probably because of the disappearance of the insects that carry it. It would be well if the plants are to be sprayed to start on the young plants with lead arsenate added to the Bordeaux for the first and second treatments.

Blossom-fruit rots, *Choanephora cucurbitarum, Rhizopus nigricans.* These fungi belong to the Phycomycetes or lower, water-loving fungi and cause in this case a blasting of the blossoms and rotting of the small young fruit, especially with the first fungus; sometimes the mature fruit also rots from the second one. Both, on the blosoms, may show a somewhat metallic lustre of their mycelium but with the former this is more evident; with the latter, the fruiting threads are shorter and the heads more compact, as seen under a lens. *See* Sweet Potato.

We have nothing to suggest in the way of prevention except that yearly rotation might in general prove helpful, and removal of the diseased fruits.

Downy mildew, *Peronoplasmopara cubensis.* On this host the mildew is not severe. It has been found somewhat in smaller spots than usual on the leaves of summer, crookneck and Hubbard squash. *See* Muskmelon.

Powdery mildew, *Erysiphe cichoracearum.* As with related hosts of the gourd family, this fungus appears more or less prominently on the leaves, in its conidial stage only, on different kinds of squash. *See* Phlox.

Scab, *Cladosporium cucumerinum.* This was seen in 1928 on summer squash producing pits, with the fruiting stage present, on the fruit in the markets. *See* Cucumber.

Mosaic. This virus disease often becomes very severe on this host, especially on the summer varieties. *See* Cucumber.

Star-of-Bethlehem

Leaf spot, *Septoria Ornithogali.* This disease was seen once, having been collected by Dr. Britton in May, 1926, on escaped plants of *Ornithogalum umbellatum* along the roadside from Stratford to Shelton. The leaves were turning yellow and dying, especially at their tips, with the fungus showing in its fruiting stage as black, embedded dots in the same. So far as we have learned, this fungus has not been reported before in this country and apparently little is known about its history. It has been found at least in Italy and Germany and Oudemans has reported a very similar, if not identical, fungus from Holland.

Strawberry

Gray mold, *Botrytis cinerea.* This is the usual trouble that we find here in the fields of strawberries, Fragaria sps., when rot becomes bad in wet weather. Some seasons the loss is considerable. *See* Geranium.

Leaf scorch, *Marssonia Fragariae.* Leaf scorch has been reported under a great number of scientific names at different times, depending apparently in part on the host it inhabits; we have listed it under *Ascochyta Fragariae* as well as *Marssonia Potentillae* var. *Fragariae.* It is very similar in its effect to the next fungus but can usually be told by the purplish-red spots, usually without the definite lighter center. When bad it causes a general browning or scorch and the death of the leaves. It is also seen as semi-cankers on the petioles and stems. Glenn Mary is a variety that has been especially susceptible to it here. On the old dead leaves, this fungus is said to develop an Ascomycete, called *Diplocarpon earliana,* as its mature stage but as yet we have not found it.

Some years ago we tried spraying a few rows in a badly infected field with Bordeaux mixture, beginning after the picking season and again the next spring before the blossoming period. The results were only fairly successful, since in most cases the spraying should start with the beginning of the new bed. Some growers mulch their plants over winter with salt marsh hay and then burn it off early in the spring to also include old dead strawberry leaves. Others rake off this mulch, cultivate the beds and then put the mulch back again. These methods or the more frequent renewal of the beds, usually at the end of the second bearing year, and the selection of less susceptible varieties, as Howard, 17 (Premier), seem to be the most practical ones for dealing with this and the leaf spot trouble mentioned later.

Leaf spot, *Ramularia Tulasnei.* This trouble has been investigated a longer time in this country than the previous one. It shows on the leaves as small, round, purplish spots that eventually have a light or white center and a definite, purplish border. The rather inconspicuous conidial stage develops as a whitish growth on the upper surface of the leaves which are said in the fall to also mature an asco stage, called *Mycosphaerella Fragariae,* but not seen by us. The fungus is common here in most beds and sometimes occurs also with the leaf scorch, *q.v.* for treatment. (Fig. 57.)

Leak, *Rhizopus nigricans,* etc. This trouble is seen occasionally in our fields but appears to be much more common on the market berries shipped here from other states. The common name applied to it indicates a soft, wet rot of the fruit.

The fungus may show as a creeping mycelium on which appear erect, fruiting threads, bearing at their end black, globular sporangia or spore receptacles. *See* Sweet Potato.

Another trouble never seen here on local berries but found one season on berries shipped from Arkansas was a rot due to *Phytophthora cactorum*. *See* also Pear.

Powdery mildew, *Sphaerotheca Humuli*. The powdery mildew has been found here only in its conidial stage. Usually it shows a slight, white, powdery growth on one or both sides of the leaves but at times it is much more evident and correspondingly injurious. In one case, when the growth occurred only on the lower surface, there was an evident curling upward of the leaves. *See* Rose.

Root rot, *Rhizoctonia Solani*. We have found the fungus causing some damage in the roots of this plant. *See* Potato.

Frosty spots. We once saw trouble, in the fall on plants set between rows of early potatoes, where the leaves showed whitish spots due to the flaking away of the cuticle. This was not due to a frost but to unusual environmental conditions earlier in the season. These spots where the flaking away occurred later showed brown dead cells beneath. Possibly the early shading of the potato vines in a wet season caused this injury due to a lack of normal transpiration of water.

Growth cracks. Occasionally this trouble is seen in the larger more irregularly shaped berries of certain varieties, especially in wet but favorable growing seasons. *See* Snapdragon.

Leaf scorch. On the other hand in very hot or dry seasons, we have seen the opposite trouble to that described under frosty spots, where the plants did not have enough water to supply their leaves with that lost by transpiration with the result that the leaves turned purplish and gradually dried up and died.

Salt water injury. About the middle of June, 1932, Mr. Stoddard was called to see a strawberry bed at Branford along the sea shore that had suddenly shown a scorch of the leaves. The injury appeared as a more or less deeply affected area around the edges of the leaflets. The outermost edges were dead and of a brownish color but next to the living tissues there was a band of purplish injured tissue. Mr. Stoddard laid the injury to salt water that came inland by an unusually high tide, since it was very definitely limited to the lower areas of the field that had been flooded.

Winter injury, etc. When strawberries are not properly mulched or are unusually exposed, especially after severe winters, we have had complaints of plants in beds dying or making feeble growth. The injury usually shows in the crown rather than in the roots. If the plants went into the winter in good shape, we naturally place the blame on winter injury. On the other hand if the trouble occurs during unusually dry spells or after very hot weather, we consider it a leaf scorch due to the lack of sufficient water.

There are cases, however, where the trouble shows in certain seasons, sometimes in patches that seem to spread especially in new soil, that we have never been able to lay definitely to either winter or drought injury. An examination of the roots occasionally shows the presence of a mycelium but never any fruiting stage in these injured tissues. Sometimes the mycelium has been dark colored but not due to Rhizoctonia. While members of this department have studied such injured plants somewhat, they have never been able to lay the injury definitely to a particular fungus or find references to such a fungous trouble.

Strawflowers

Yellows. The only disease of these plants we have recorded was the true yellows on specimens of *Helichrysum bracteatum*, seen once in a flower bed alongside asters, *q. v.*, also showing this disease.

Sumac

Leaf curl, *Exoascus purpurascens*. While the troubles reported on these hosts were collected chiefly on wild specimens of plants, they may be looked for also on the cultivated ones. The leaf curl was found years ago by Thaxter on the leaves of *Rhus copallina*, causing a purplish to whitish discoloration and crinkling of the leaves very similar to the peach leaf curl, *q. v.*

Powdery mildew, *Sphaerotheca Humuli*. This was found, in its conidial stage only, in a nursery on Lobadium sumac, *Rhus canadense*, but in nature it has been collected both with conidia and perithecia on *R. copallina* and *R. typhina*. *See* Rose.

Fasciation. We have seen a wild specimen of *Rhus glabra* where the normal stem gradually flattened out toward the end for several feet and formed eventually a flat surface more than twice as wide as the narrowed thickness and ended in two short incurved tips. *See* Asparagus.

Sunflowers

Leaf spot, *Septoria Helianthi*. While this leaf spot has been reported on a number of species of Helianthus, we have found it here only on *H. annuus*, the tall sunflower of Kansas. The spots are usually reddish-brown, angular and one-third of an inch or less in diameter, though they sometimes run together into indefinite areas. The embedded fruiting stage when mature may, under a lens, show black specks with a light center in these spots. Apparently no other stage is known.

While considerable injury may show on the leaves, nothing is done to prevent this trouble because of its little economic importance. It might yield to proper spraying.

Powdery mildew, *Erysiphe cichoraccarum*. This was found here on cultivated *Helianthus annuus, H. atrorubens, H. multiflorus, H. tuberosus*, as well as on several wild species with only conidia or with both conidia and perithecia. *See* Phlox.

Rust, *Puccinia Helianthi*. The O, I, II, III stages all occur on the leaves of Helianthus. The O, I stages usually appear first in the spring (we have one specimen collected in August, however) and are, at first, on definitely yellow but later darker spots with the inconspicuous O stage in a small group at the center of the upper surface. The more evident aecia are grouped below as closed or later open, toothed cluster-cups. We have collected these stages only occasionally on *H. decapetalus* and *H. divaricatus*. The II, III stages are scattered more or less abundantly over the under side of the leaves (chiefly) as evident, dusty pustules. The II sori are reddish-brown and the III sori are black-brown and less dusty. These stages have been collected on *H. annuus, H. decapetalus* (including the cultivated *multiflorus*), *H. divaricatus, H. giganteus* and *H. tuberosus*.

Destroy the old dead plants in the fall or rotate to new ground and if rust appears the next year pick off the first infected leaves.

Sweetpea

Black root rot, *Thielaviopsis basicola*. This has been found a few times in recent years on sweetpea, *Lathyrus odoratus*, but not causing much injury. *See* Tobacco.

Crown gall, *Bacterium tumefaciens*. In January, 1922, and again in April, 1924, the writer and Dr. McCormick investigated a new disease of sweetpea, in a greenhouse at West Hartford, that was causing serious trouble. The roots of the plants in some cases were rotting, due chiefly to the Thielaviopsis fungus, but the conspicuous trouble was the evident, gall-like growths at the base of the vines. These were the abnormal, aborted stems and leaves, showing a short, swollen, irregular growth, usually one to two inches high, that had a cauliflower-like appearance. Preliminary spraying experiments, by Dr. McCormick, with water extracts from the crown galls on young seedlings did not show sufficiently definite results to claim bacteria as the cause however.

A somewhat similar trouble was reported by Grevillius (Zeitschr. Pflantz. Krankh. **21**:17-27) in 1911 on *Asparagus Sprengeri*, and apparently our own trouble by Oberstein (Zeitschr. Pflanz. Krankh. **22**:463-4) in 1912 on sweetpea, both being from European countries. Neither of the writers determined the cause of the trouble. Nellie A. Brown, (Phytopath. **17**:29-30) in 1927 was the first to prove that this trouble on sweetpeas in the United States was due to the crown gall

organism, by isolating bacterial cultures from the infected sweetpeas and re-inoculating them into very young healthy ones.

Rotate, change or sterilize the soil where this trouble occurs.

Powdery mildew, *Erysiphe Polygoni.* This has been reported, in its conidial stage only, a few times on this host as more or less conspicuous. The scientific name employed is that usually given by others but, because of the presence only of the conidia, the mildew might belong to the genus Microsphaera which also has been reported on this host.

Root-seedling rots, *Fusarium* sp., *Phytophthora cactorum, Pythium debaryanum, Rhizoctonia Solani.* On sweetpeas showing yellowing of the foliage and stunting of the vines as a result of rotting of the basal parts and roots, we have found at one time or another all of the above fungi, occasionally two together. While we hold each separately responsible for such rots, it is quite possible that one or two are more directly responsible for the start of the trouble.

If manure is used, place it deep in the soil and cover with a shallow layer of earth. Trench the seed and plant shallow at first and gradually cover with the soil as it comes through. Cultivate the top soil around the plants frequently to maintain a dry mulch and if necessary scatter a little mixture of sulphur and lime around them. Change the planting location each year and if trouble still bothers sterilize the soil as indicated under damping-off of Spinach.

Mosaic. The light-green mottling, interspersed with the natural green of the leaves, has been found occasionally on greenhouse and garden sweetpeas. It causes some damage and is evidently a true virus mosaic. So far as we can judge it is not distinct from the mosaic disease of tobacco, *q.v.* It can be carried by aphids.

Sweet Potato

Black rot, *Sphaeronema fimbriatum.* The sweet potato, *Ipomoea batatas,* is rarely grown here, apparently because we are too far north and not because we lack sandy soils. Recently, however, there has been some interest in growing this crop among the tobacco farmers. The only time we have seen a disease on plants grown in the state was in the fall of 1933 when Dr. Jones brought in specimens from the Station's Vegetable Garden at Windsor, showing the black rot on the variety Long Stem Jersey where it proved serious. This showed as sunken, dark-brown to black spots of somewhat variable size on the roots, some of which produced the fruiting stage of this imperfect fungus. The bases of the pycnia were embedded in the skin, but showed above as free necks in a black, hair-like growth. At the fringed tips sometimes could be seen the pinkish mass of oozing spores. The disease is said to be troublesome in storage as well as in the field and is general in the sweet potato sections of the United States.

We have had no experience in controlling this trouble but others advise the selection only of healthy sprouts from disease-free seedbeds or tuber treatment with corrosive sublimate, rotation in the fields and extra care in storage.

Soft rot, *Rhizopus nigricans.* This trouble is the chief one with which storekeepers and housewives have to contend. The non-septate mycelium of the fungus is hidden in the rotting tissues but under suitable conditions there is often evidence of the fruiting stage as a growth of black, stalked sporangia. This fungus causes a wet rot of certain other plants as well as being a saprophyte on dead substances. It is listed here only on apple, peach, squash and strawberry besides on sweet potato. A very similar rot of the sweet potato is sometimes caused by the bacterial soft rot organism, *Bacillus carotovorus.*

Fasciation. We have seen this malformation several times recently where the ends of the vines were flattened out an inch or so wide and ran out for a distance of two or three feet, bearing numerous leaves on the flattened surface. *See* Asparagus.

Sweet William

Crown rot, *Sclerotium Delphinii.* This serious rot of a great variety of herbaceous plants was found once on this host at Wallingford in 1932. *See* Larkspur.

Rhizoctonia rot, *Rhizoctonia Solani.* This has been reported a couple of times as causing rotting at the base of these plants, *Dianthus barbatus. See* Spinach and Potato.

Rust, *Puccinia Arenariae.* The rust has been found a few times on this plant in private yards. It has only the III stage which is evident on the leaves, chiefly the lower surface, as roundish groups of lead-colored blisters that are reddish-brown after the epidermis ruptures and discloses the embedded spores. These apparently germinate in position and spread the rust or carry it over the winter before germination.

Sweet Vernal Grass

Smut, *Tilletia Anthoxanthi.* The smut confined to this host, *Anthoxanthum odoratum,* occurs inconspicuously in the seeds, being revealed only by their slightly larger size and their smutty appearance when broken open. It has been found in North America only in Connecticut, Pennsylvania and Nova Scotia and there only rarely.

It has never been conspicuous enough to require preventive treatment in Connecticut but probably could be controlled by the various seed treatments.

Sycamore

Anthracnose, *Gloeosporium nervisequum.* This is the prominent disease of our sycamore trees, *Platanus occidentalis,* killing the young leaves as they come out in the spring and causing reddish-brown areas on the leaves that escape the earliest infection. Often these areas or streaks spread along the ribs, as indicated by the specific name. Some scientists consider the trouble on the oaks the same species as this on the sycamore. An imperfect stage carries over on the young twigs and produces infection of the leaves. The fungus has also been connected with a saprophytic Ascomycete, on the old leaves in the spring, known as *Gnomonia veneta* but which has not yet been found by us.

Sometimes the leaves are so badly injured in the early season that a new crop has to be put out to carry the tree along. Continued infection of the leaves year after year causes the trees to produce weakened limbs that may finally die, giving them the appearance as if on the last lap to destruction but they usually pull through. Here the European sycamore, *P. orientalis,* one of our street trees, seems to be less subject to the disease or at least escapes it while young.

We advocate at least two sprayings with Bordeaux—one a dormant spray just before the buds begin to break and the second on the very young leaves after the buds have opened, with a third treatment in some cases when the leaves are half grown. It can do no harm to rake up and burn the leaves after defoliation in the fall and possibly it may do some good, especially if much infection comes from the asco stage.

Powdery mildew, *Microsphaera Alni.* This mildew has been reported chiefly by nursery inspectors, apparently not being very common or injurious. *See* Lilac.

Electric injury. We have seen this trouble from feed wires along the trolley tracks. When the insulation had been worn off and the exposed wire came in contact with the wet leaves, the injury was evident by their premature death. Occasionally where direct contact was had on large limbs we have seen a local burn that resulted in their death as well.

Frost injury. Certain years, when late frosts occur after the leaf buds begin to emerge, we find similar, fatal injury to the leaves all over the tree that very closely resembles the anthracnose trouble.

Teosinte

Smut, *Ustilago Zeae.* This Mexican relative of corn, known as *Euchlaena mexicana,* is grown here rarely as a curiosity. Only at the Station farm have we found the smut on it but we consider it to be the same species as the one attacking corn, *q.v.*

Timothy

Black mold, *Helminthosporium* sp. In July, 1926, and again in 1928, we found at the Mt. Carmel Station farm roadside timothy, *Phleum pratense*, showing a little spotting but more evidently a premature yellowing and then a browning of the leaves. These leaves showed spores of the above fungus as a probable cause, as well as those of Cladosporium and Macrosporium which were more evidently saprophytes. There was, however, the possibility that drought rather than the Helminthosporium was really the primary cause of the trouble. We have determined the fungus under the generic name only since it may be only a weak parasite occurring on a variety of grasses (possibly *H. gramineum*) rather than a specific one limited to a single host genus as is indicated by the work of recent authors in classifying the species of this genus. *See* stripe under Barley.

Ergot, *Claviceps microcephala.* The ergot on this plant is much smaller than the one found on rye, *q.v.*, as it is rarely over a quarter of an inch long and relatively thinner. One or few of these sclerotia may be seen on the spikes of timothy extending out a short distance beyond the floral parts. The same species has also been found here on *Dactylis glomerata* and possibly on *Phalaris arundinacea*. This latter host has the narrow sclerotia but often reaching a length of half an inch.

Leaf spot, *Heterosporium Phlei.* Quite distinct from the Black mold in its effect on the leaves is this fungus which was sent in by County Agent Wing from Pomfret in June, 1933. It produces definite, small, oval to oblong spots, more or less abundantly, in the green tissues. These spots are chiefly 1–2 millimeters in length and have a straw-colored center and usually a very definite purplish border. While our specimens had few spores, these were obtained abundantly by placing the leaves in a damp chamber for a few days, but the olive-green growth of the conidiophores and spores was not entirely confined to these spots. The spores were not so prominently echinulate as figured by Gregory, who originally described this species (Phytoph. **9**:576) in 1919 from New York state.

Rust, *Puccinia graminis.* Both the II and III stages of this rust have been found to be common on this host. There are more than eighty specimens in the herbarium from various localities in the state. However, we have not found it very serious in hay fields. It is usually seen on roadside plants. The II stage shows as reddish-brown, elongated pustules while the III pustules are black and more permanently embedded, both occurring chiefly on the stems and sheathing base of the leaves. These sori are surrounded by the evident, ruptured epidermis. The I stage occurs as cluster-cups in the leaves of the barberry, *q.v.*, in the spring and early summer. Besides occurring on timothy, this rust is reported here on barley, oats, orchard grass, redtop, rye, wheat. It also occurs on a few wild grasses.

While common on certain of its hosts, it is not injurious enough to warrant any special treatment. In the west where it is more serious in the grain fields, laws have been passed for eradicating both wild and cultivated barberries. Many years ago this same method was tried in New England. The late Dr. Jenkins, Director of this Station for years and interested in the early history of Agriculture in Connecticut, in 1921 handed the writer a memorandum on this subject, part of which is given here:

"In 1784 the laws of Connecticut provide that anyone, with the advice and consent of the civil authorities and selectmen of the town, may during March, April, October and November enter any lands where barberry bushes are growing and dig up and destroy them without being liable to any action, suit or damage. . . . . In 1796 the town of New Haven granted $200 for the purpose of destroying barberry bushes within its limits and they were 'principally destroyed. The method adopted to destroy them was to eradicate them.' I'll bet a student of the classics wrote that last sentence. E. H. J."

Smut, *Ustilago striaeformis.* This occasionally occurs on the leaves. *See* Redtop.

Proliferation. In the spikes we have sometimes found one or more larger, elongated, leaf-like bodies instead of the normal spikelet. *See* Rose.

Toadflax (Butter and Eggs)

White smut, *Entyloma Linariae.* The only fungus we have found on this plant, *Linaria vulgaris*, which occurs here chiefly as a weed escaped from cultivation, is this smut which is inconspicuous and shows as small, light-yellow spots on the leaves.

Tobacco

Diseases and Injuries. We have listed in this state on *Nicotiana tabacum* nearly fifty of these troubles, distributed as follows: Fungi, 8; Bacterial, 3; Virus, 2; Nutritional, 5; Mechanical and Environmental, 15; Undetermined, 15. We can give here only a brief condensed statement of these.

Bacterial angular spot, *Bacterium angulatum.* We first noticed this trouble in July, 1922, when we were making a survey of the tobacco troubles during the years from 1920 to 1922. We found it first in the general region of New Milford and have seen it since, more or less common in wet years in the Housatonic river tobacco region but less so in the Connecticut river tobacco section to the east. It forms small, reddish-brown, angular spots that are more or less grouped and become semi-pellucid when wet. On the whole it is not usually very serious, especially when compared with the bacterial wild fire with which it occasionally occurs on the same plants in wet seasons. While we have made no attempts to isolate the organism causing the trouble or any serious attempts to reproduce it by inoculations, we have no doubt of its bacterial nature since we have compared it with similar specimens from the south where the disease has been more thoroughly studied.

FIGURE 58. Tobacco black root rot.

FIGURE 59. Tobacco mosaic.

FIGURE 60. Tomato point rot.

Bacterial soft rot, *Bacillus carotovorus.* This is likely to show in wet seasons especially on land where nitrogen is used in organic form, such as fish scraps, manure or cover crops plowed in late. Usually only an occasional plant shows the trouble by the interior of the stems developing a wet rot of the tissues and becoming hollow, when it is known locally as hollow stalk. Sometimes the plants rot off at the base and the disease is more general in low spots of the fields. *See* Iris.

Care in the use of such nitrogenous fertilizers, especially in low or wet fields, is necessary.

Bacterial wild fire, *Bacterium tabacum.* In 1920 this disease was definitely recognized in the Connecticut valley although it had probably been present one or two years previously and in July, 1922, it was first found in the Housatonic valley. During the first few years after its discovery it became very general in the tobacco fields of both of these regions. It was chiefly due to the alarm caused by this disease and the interest brought about by the tobacco surveys of 1920 and 1921 that the tobacco substation at Windsor was established in 1921. In recent years the trouble has not caused so great damage probably largely because of knowledge gained concerning its nature and methods of control.

The disease is characterized by a sort of wet rot of the very young plants in the seed bed and later by the yellow, roundish spots on the leaves of the older seedlings. In the field these yellow spots, under favorable moist conditions, become more abundant as the plants begin to grow and in time turn to white or brown dead spots with a yellow halo surrounding them. With increasing age of the plants the spotting may become very abundant and more or less run together into irregular shapes of dead tissue and this may be torn or dropped out. In fields where the trouble has been favored throughout the season by moist conditions, the injury may be so great that the entire crop is lost or not worth the cost of harvesting and curing. *See* Bull. 239.

The trouble comes about entirely from the seed bed and does not spread readily from field to field or from a diseased crop previously on the same land. Therefore it is now largely controlled by careful attention to the seed bed, chiefly by spraying with Bordeaux mixture. It does not pay to plant a field from a seed bed in which the seedlings have shown signs of the disease. Even if apparently healthy plants only are used, when the season later is wet, trouble is likely to follow.

Black root rot, *Thielaviopsis basicola.* This is common in the seed beds where alkaline fertilizers, such as wood ashes or lime, have been used or where the soil is more nearly alkaline than that in normal seed beds. When it is bad young plants make a slow growth with the leaves often forming a rosette close to the soil without much change until new roots are developed. Examination shows a black discoloration of them due to this fungus rotting the tissues, hence the name of black root rot. In the fields the trouble is also found when plants are used from infected seed beds or the fertilizers and climatic conditions favor its development. Such infected plants, sometimes in spots or generally over the field, make a less favorable growth due to the preliminary stunting. Later field infections, due to favorable, cool, wet weather of the early season, favor the growth of the fungus. On this latter account later planted tobacco, during the warmer weather, is said by some to be less injured. The type of fertilization in the field also has some effect on the development of the fungus as has already been indicated for the seed beds. (Fig. 58.)

In the past a good deal of poor tobacco has been laid to this trouble even when the roots did not always show its presence in sufficient amount to indicate it as the primary cause. Round Tip, at one time in favor here after its first introduction, seemed to have more resistance to this fungus than the other varieties grown here commonly or at least it had a more vigorous root system that was helpful. On the other hand a certain type of Burley was especially susceptible to injury by the fungus and was used as an indicator of its presence. So far the other hosts on which this rot has been found here are pansy, pea, sweetpea and violets.

Attention to the seed bed, especially as to alkaline fertilizers and sterilization, and proper field fertilization are helpful in preventing this trouble. Recent attempts to develop resistant strains of Havana, Round Tip and Cuban tobacco may eventually largely solve this problem.

Canker, *Sterigmatocystis niger;* **Must,** *undet. organisms.* Both of these warehouse troubles develop in the cases after the tobacco is packed for fermentation. The canker is due to the saprophytic, imperfect fungus named here which forms a black growth of conidiophores and spores on definite spots of the overlapping leaves of the hands and the mycelium of which works through them. It develops a wet rot that eventually when dry causes these large infected spots to become brittle and easily broken as well as discolored.

Favorable conditions of heat and moisture as well as the presence of the spores, rather commonly present in nature, favor the development of this trouble so care has to be used to prevent these optimum conditions.

Must is a somewhat similar trouble due to about the same causes and is so named because of the musty smell given to the tobacco. However, from the few specimens we examined years ago, we were not able to identify the specific cause. These specimens showed a whitish growth of bacteria and fungi along the midribs but no definite specific organism that seemed to be primarily the cause.

In the past, dealers who had this trouble sometimes renovated the musty tobacco by washing it with rum.

Frost fungus, *Botryosporium pulchrum.* The fungus receives its common name because of its frost-like appearance. The white, branched conidiophores with their adhering spores are a pretty sight when seen growing on the refuse tobacco on the floors of the tobacco barns. It also occasionally occurs as a semi-parasite on the curing leaves there. Sturgis speaks of it in this latter case as follows: "Stems affected with this disease are covered with pure white patches having the appearance of a long pile velvet. The patches spread rapidly, encroaching upon the veins of the leaf and destroying the tissue and in the end inducing a more or less widespread decay, especially in the neighborhood of the midrib and veins." The same fungus is also sometimes found on other languishing plants in the greenhouses.

The tobacco rubbish on the floors of the barns should be cleaned out to prevent the spores being blown to the tobacco hung there for curing and care should be paid to the heating and ventilation.

Fusarium spot, *Fusarium affine.* This apparently weak parasite has been found as the cause of roundish spots, usually less than half an inch in diameter, on the leaves. These spots may be distinct or more or less run together. They stand out best on yellow leaves as a brown or bronzed color but with a purplish tint on the green leaves. They have been found on the old languishing leaves in greenhouse plants but more commonly in the Broadleaf fields on the old basal leaves on the ground from which infection may come. The fungus is apparently never conspicuous on these spots but can be obtained in cultures from them.

We do not consider it, so far, a serious trouble that needs any special treatment for control.

Seedling rots, *Pythium debaryanum, Rhizoctonia Solani, Sclerotinia minor, S. sclerotiorum.* Beside the black root rot of seedlings in the beds, the above four fungi have also been found causing trouble. The Pythium fungus usually attacks the roots and forms a reddish rather than a black rot of them. The fungus is ordinarily rather indefinite on the outside as whitish threads but is evident by the roundish oospores found within the tissues. It is the same species found on a great variety of seedlings as discussed here under Spinach. In our tobacco disease-survey of seed beds in 1920 and 1921, we found this Pythium more common than any other of the damping-off fungi.

The Rhizoctonia, as already described under lawn grass and spinach, was also common and while it rots the roots it may send mycelium above the ground to rot off the parts above as well. **It is said to favor an acid soil.** ***See*** **also Potato.**

Of the two Sclerotinia, the *S. minor* has only been found once on tobacco while the larger sclerotial form, *S. sclerotiorum,* was seen a number of times but both act alike. Like the Rhizoctonia the seedlings may be rotted down in bunches and often a thick, white mycelial growth may show on these parts above the ground. Both fungi develop rather characteristic, black sclerotia in artificial cultures. *See* Lettuce.

Care in the watering and ventilation of the seed beds is the prime factor in controlling all these troubles. Of course sterilization of the beds is even more effective. Both steam and chemical sterilization have been used. In the latter case both formalin and acetic acid, the latter the more recently tried, treatments have been used. Steam sterilization, if done properly, is generally more successful and keeps down the weeds better. In certain cases, however, the chemical treatment is the only method at hand for the grower. ***See*** **statement under soil treatment.**

Stem canker (Foot rot, Sore shin), *Pythium debaryanum, Sclerotinia sclerotiorum.* In the field one occasionally finds plants weakened by cankers at their base so that they are easily broken off there. These are usually plants that were infected in the seed beds by these fungi but whose tissues have become so hardened that the rot at these places has stopped or has progressed slowly, especially in the case of the Pythium, to form a dark, foot rot. Possibly other fungi at times may be responsible for these troubles but as yet we have not found them.

Nematode rootknot, *Heterodera radicicola.* So far this trouble has been seen only rarely on greenhouse plants grown at the Station in New Haven. *See* Cucumber.

Abnormalities. These are not frequent and so do not constitute any menace to tobacco growing here. They are, however, interesting because of their different types and causes. They may be briefly mentioned as follows: *Albinism* shows as

whole plants or certain leaves or parts of a leaf in which the normal green color gives place to a whitish-yellow or pure white color. It is quite distinct from mosaic and does not seem to be contagious but possibly it is an inherited character as is often shown by crossing of plants. *Crinkled leaf* is rarely shown by the crinkling and puckering of certain leaves of plants and in some cases seems to disappear later. *Curley dwarf* is much like the similar trouble in potato plants but whether due to a "virus" is not known. Unusual *mottling* or *golden marbling* is rarely seen on the leaves of certain plants that suggest abnormal fertilization. *Strap leaves* are shown by very narrow leaves, often largely limited to the midrib; they are apt to occur on badly mosaic plants or on whole plants that have been stunted in some way by unfavorable soil and weather conditions. *Twin plants* and *twin leaves* are apparently due to early injury to the bud or young tissues that produce them. They are seen so far only in seed beds because they would not be set out in the fields. We have never seen a case of *fasciation* on this plant.

Brown root rot. This is a trouble that rots the roots causing them to turn a brown color. There is usually no indication on the roots as to the cause. The trouble is complained of chiefly in the fields because the rotting of the tap and side roots delays the vigorous development of the plants until new roots are formed above these. Even then the plants never fully recover. They are likely to wilt more easily in hot weather than normal plants and fail to produce a satisfactory crop. Certain fungi, as Fusarium, and adverse fertilization, such as calcium deficiency, have been claimed as the cause but the latter seems to be more likely as shown by recent investigations. The infected fields or spots often progress in severity.

The Station in experiments has found that certain types of fertilization and cover and rotation crops seem to lessen this trouble. The use of stable manure and an annual application of lime were helpful.. Resting the land to weeds also was favorable to its decrease. Sterilization, by steam and to a less extent by formalin while beneficial, is not practical for wholesale treatments. Rotation of tobacco with forage crops (timothy, corn, rye, alfalfa and clovers) and the use of timothy as a cover crop were apparently detrimental rather than beneficial.

Fertilizer injuries. *See* Addenda.

Fire injury. Injury of this type occurs only on tent tobacco when fire from lightning, smoking, etc., causes burning of the cloth covering, with resulting injury from the burning cloth dropping on the tobacco beneath. During the war owners were especially suspicious of fire that they thought might be set intentionally, so a more careful watch of the tents was made at that time.

Frost spot and mottling. We have seen white specks or spots, in seed beds covered with cloth or those with glass that were not covered at night or had broken glass, appear as the result of freezing weather. These spots, at times, are difficult to distinguish from fertilizer burn and sun scorch spots.

In the fields in June, after the tobacco has been set out, there occasionally occurs freezing temperature in certain exposed fields in which a more evident type of injury develops. The injury comes on suddenly and does not progress to other parts of the plant, although some stunting may result. This injury shows as irregular, white specks, spots or areas in the leaves, rarely on the stems, with a more or less deformity of the tissues when severe. The chlorophyll is killed leaving white spotting without very evident injury to the cells. Sometimes the grower finds the injury only on certain plants; it is quite likely those injured had moisture on the injured parts at the time of the frost.

Hail injury. Such injury has long been known as serious in local regions in the Connecticut valley. Sometimes the injury has been so local that one grower has had his tobacco seriously injured while a neighbor entirely escaped injury from this cause. The hail stones tear out or rend the leaves in such shape that they are of no use for wrappers or binders. We have seen leaves that had numerous holes like a large sieve and the stalks showed injury by discolored dents. The trouble occurs on both field and tent tobacco, in the latter case causing damage to the cloth as well. Sometimes the hail stones accumulate on the cloth until their weight tears it apart and drops them in large piles on the ground where they sometimes last until the next day despite the high temperature. Some years are worse than others

but we have clippings from local papers for various years estimating the damage by hail and wind that run from thousands up to hundreds of thousands of dollars.

Leaf spots. There are a number of different leaf spots concerning the cause of which we are still in the dark. It may be that some are due to a lack or an excess of certain elements in fertilization. Some may be due to obscure bacteria, others to "virus" types of injury and still others to unfavorable weather conditions. We group these spots, unknown as to cause, here together. *White speck* or *spot*, often seen moderately on Havana tobacco scattered on the leaves, is indicated by small white spots or specks that when they occur in circles we call *ring spots, q. v.,* which are said to be due to a virus. Similar *brown spots*, usually circular in shape, occur on various types of tobacco but are classified here as one. No definite organism has been associated with them here although in some sections somewhat similar spots have been laid to bacteria. Some of the spots, known as *Broadleaf spot* and *John William spot*, usually white in color but sometimes brown or dark and then changing to white, come on the lower leaves exposed to the dirt and under certain weather conditions seem to act much like wild fire. So possibly they are due to bacteria or a "virus," though we have never spread them by using infected tissues on healthy plants.

Lacking the data as to the cause of all of these troubles, we have as yet no means for control when they become serious in certain seasons.

Lightning injury. This trouble is seen occasionally as in potato fields. The lightning strikes a definite place in the ground and kills or injures the plants in a somewhat circular spot around the place that was hit. On the edge of the spot the plants may be alive and continue to grow but show cankers at their base and wilted or curled leaves, especially near their midrib.

Mosaic (Calico). *See* Addenda. (Fig. 59.)

Pole burn (Sweat). Personally we have not had much experience with this trouble though Sturgis was an early investigator here and Anderson, of the Tobacco Station, has been interested in it in recent years. The trouble occurs in the barns after the green leaves or stalks have been hung there and the temperature and moisture are favorable for the development of bacteria and molds and a wet decay results before the tissues are thoroughly dried out. Sturgis dealt largely with the type of barns that favored the drying of the tobacco in the best possible way and he and others also considered artificial heat as a preventive.

Anderson advocates the use of charcoal, in certain containers for the regulation of moisture, as a means for avoiding the trouble. In one of the Tobacco Substation bulletins he says. "A conservative estimate of the loss to Connecticut growers this year (1928) is over a million dollars. . . . . Firing to wilt, *i.e.*, within a few days after filling the shed and while the leaves are still green is a good practice but is not always necessary for prevention of sweat. Pole sweat never attacks leaves when they are in the green stage. The late yellow and early brown stages are the danger stages. . . . . If the tobacco is in those stages and wet weather sets in, with high humidity preventing evaporation from the leaves, it is time to start firing. Don't wait until the leaves begin to 'puff' and the midribs 'strut'." For details of treatment consult the Tobacco Substation at Windsor. *See* Rept. **1891**:168: **1899**:265: Bull. **299**:195.

Rain spot. This occurs in rain storms, where the plants are of some size, on the lower leaves especially of Broadleaf. The drops hit the upturned under surface and there result soon afterward roundish spots, usually not showing at all on the upper surface, of a dark, copper color or more rarely a silver gray on certain plants. Generally no permanent injury is produced. Apparently the leaves absorb this water, giving at first a water-soaked appearance in these spots. Sometimes extended areas of the leaves on the ground develop a purplish or grayish color on their under surface. It is doubtful if there is much bruising injury where the rain drops hit the leaves.

Ring spots. One finds on the leaves of scattered plants of tobacco, usually on Havana here, small white spots generally arranged in a circular manner and often more than one circle to a leaf. The chief difference between these and the ordinary white spots found more frequently on the leaves is their circular distribution. Their cause may be the same but certain investigators have shown

by experiments that these ring spots are due to a "virus" that can be transmitted from infected leaves to the healthy. We have never tried carefully to produce these spots in this way from local diseased specimens, but believe the trouble here is the same as that described by these investigators. The regular distribution of the spots, however, gives one the impression that they might be due to the puncture of some insect, though there is no proof of such an agent as a possible contributing cause.

While we have not tried to produce this trouble from the ring spots on leaves grown in this state, we have produced similar injury by the pricking method, from another trouble sent here from elsewhere. Recently, too, we have produced similar spots on the lower, mature leaves of young plants when they were inoculated by the hand-rubbing method, from what seemed to be straight mosaic leaves kept sometime in the herbarium. The young upper leaves of these infected plants, however, produced the normally mosaic leaves without these white spots. Yet when we tried again to reproduce these ring spots by infecting other young tobacco plants, using only the ring-spot lower leaves showing no visible mosaic appearance, the leaves of the newly infected plants all produced typical mosaic plants with no white spots even on their lower apparently normal leaves.

Rust. We limit this term to those plants that show an irregular and often an extended, reddish-brown killing of the leaf tissues. In our experience this is usually limited to the killing of mosaic-infected leaves especially when suddenly exposed to bright sunlight or to extremes of dry, hot weather. While normal leaves possibly may be subject to similar injury, they are certainly less likely to develop it while mosaic leaves, even in somewhat normal conditions, may occasionally show such dead spots. We have in mind a case where mosaic plants were topped during a hot period and an unusual case of rust developed. A grower once complained to us that he always had this trouble on a certain piece of land. In the hot, dry air of the greenhouse, mosaic plants often show this trouble conspicuously.

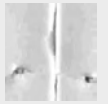
Sand blast. Most tobacco here is grown in rather sandy soils. During wind and rain storms, the sand may be blown against the wet leaves or the leaves are dashed against the soil and the slight injury caused is known as *sand blast*. This is shown by small, white, specks on both surfaces of the leaves and is found most commonly on the leaves near the ground.

Spray, Poison and Fume injuries. Spraying with Bordeaux, preferably home made, is apparently more desirable than dusting, and in general little injury results, chiefly a yellowing of the leaves. Years ago we saw some injury from a commercial form of Bordeaux containing a poison, that was know as *purple speck*. Injury results when Paris green is used to kill insects and accidentally gets on the leaves or next the stems.

Fumes from boards recently treated with creosote may cause injury to the plants in the seed beds. Injury has also been observed on field plants next to state roads sprayed with hot preparations of tarvia or road tar to keep down the weeds. In these cases the lower leaves of the few rows of tobacco near the road may show the characteristic injury from the fumes by the varnish-like glaze on their upper surface with a slight upturning of the edges. In some cases dead spots appear when the injury is severe.

Water injuries. This is sometimes seen after severe rain storms in low, wet fields from which the water is not easily drained off. As a result the tobacco roots in this water covered or soaked soil are smothered for lack of air and a sickly yellow color of the foliage results, much as in nitrogen starvation. Abundant but well distributed moisture, on the other hand, coupled with favorable fertilization, in certain seasons may make a luxuriant growth of leaf but with less favorable texture and color when the leaves are cured.

Wind injuries. Torn leaves, following hail and rain storms, are in part caused by heavy winds. The plants in the wet soil may be blown down by heavy wind and have to be straightened afterward. If this is not done these plants try to straighten themselves, sometimes making permanent bends in the stalks in their effort to go toward the sun and away from the earth.




Tomato

Anthracnose, *Colletotrichum phomoides.* This is a trouble occasionally prominent on the ripening fruit of *Lycopersicum esculentum,* the scientific name of the tomato. It starts as small translucent and then black specks that eventually enlarge into circular, sunken spots which may run together with evidence of the fruiting stage shown by the orange ooze of the spores of this imperfect fungus. The black setae that accompany these spores may be more or less abundant; when not so evident the fungus then takes the type of a Gloeosporium. It is most abundant in wet seasons at the ripening time.

Frequently nothing need be done for its control beyond picking and destroying the infected fruit and care in not leaving the sound ones to over ripen.

Bacterial blight, ?*Bacillus solanacearum.* This trouble acts much like the black leg as described here on potato, *q.v.* Both were found on these two hosts about the same time in 1903 and were noted under the above Bacillus. The Southern brown rot, as it is commonly known, however, rarely occurs this far north: Later the black leg was described from New England on potatoes, and the trouble on our potatoes was identified as that. We are now inclined to believe that the trouble on the tomato, which we have not recently seen, may have been the same thing. Later the Michigan bacterial canker, described below, was found here and this earlier trouble possibly could have been it though apparently it was somewhat different, being more particularly confined to the vascular rather than to the epidermal systems.

Bacterial canker, *Aplanobacter michiganense.* While this disease, also known as Michigan canker, is said to be a vascular wilt and progresses from the lower leaves upward, we have noticed it at first merely as a wilting of the leaves which, losing their color, dry up on the stems. Eventually a brownish streak appears under the epidermis on the petioles and stems, running lengthwise of them and often showing only on one side. The epidermis may soften or rot away from the tissues beneath and eventually there may be a general rotting of these soft tissues. But to the writer the trouble seems to progress downward rather than upward and may finally reach the base of the plant and cause its death. It does not seem to be a vascular invasion, as with black leg where there is a general rotting of tissues below and in the hard tissue above a browning of the vascular system which is seen only when cut across.

This bacterial canker was first definitely recognized in this state in July, 1924; it was more common in 1925 and 1927, though since then it has been reported only occasionally. It is said to be carried by the seed. In some cases we have found it very destructive in the fields but we have never been quite sure that it spreads there to any great extent, apparently having come from plants infected in the seed beds and then showing up gradually or suddenly on those in the field.

Care in the selection of clean seed or its sterilization, if doubtful, and similar care of the seed bed should be used. Just what good could be accomplished in the field by spraying, especially if the spread there is limited, we are in doubt. Rotation, especially after the trouble appears in the field, however, should be followed the next year for safety.

Blight, early, *Alternaria Solani.* This appears chiefly on the leaves though we have seen a little on the fruit. It varies in different years but is usually not very serious. *See* Potato for further details.

Blight, late, *Phytophthora infestans. See* Addenda.

Fruit rots, *Macrosporium. Tomato, Fusarium* sp. Both of these fungi were noticed by Thaxter on ripe tomatoes in the early days of the Station. They are the chief ones observed so far by the writer in the fields, where he considers them primarily as saprophytes. The first one occurs on the green as well as on the ripe fruit, chiefly as a dry rot, and often shows as a secondary effect following Blossom-end rot or other troubles. It is evident as an olive-black, external growth of the conidiophores and conidia. The fungus is probably an Alternaria, possibly *Alternaria fasciculata,* as given by some authorities. A recent trouble in the south known as nailhead spot, which is especially bad when the tomatoes are shipped north, may be caused by the same or a similar fungus.

The Fusarium fungus is most prominent on the ripening and over ripe tomatoes and is likely to cause a wet rot. This fungus frequently shows as an evident, white or salmon, external growth. There are, no doubt, other fungi than these two that cause trouble as distinct or associated fungi on the ripened fruit in the fields as well as on fruit shipped here from outside the state.

The chief helpful measures against these saprophytes or semi-parasites is to pick and destroy the infected fruit and to gather the ripening sound ones regularly.

Leaf mold, ***Cladosporium fulvum.*** **We have seen and had complaints of this** trouble chiefly in the greenhouses. It produces most of its injury directly on the **leaves and indirectly later to the whole plant.** The leaves are invaded by the fungus and later are covered by an evident, olive-brown growth of the conidiophores and spores on their under surface with discoloration of the upper. The leaves finally turn yellow and dry up chiefly from the base of the plant upward. Apparently no other stage has been found. This trouble was first mentioned by Thaxter in 1889, about six years after its first discovery, and again in 1890, both reports apparently being on out of doors tomatoes. It was also mentioned by Sturgis in 1893.

In the greenhouses care should be used in watering, especially on the leaves **when this trouble is present.** The temperature of the house also should be kept down as low as is consistent with good growth. Spraying with Bordeaux, if used, should start early and be repeated as necessary. The ripening fruit should be picked before spraying if any treatments are needed at that time.

Leaf spot, *Septoria Lycopersici.* This is our most common and so our most serious leaf disease of tomatoes. It occurs also on the stems and fruit but not **seriously.** If it occurs early and abundantly it may cut down the yield considerably but in this state this does not usually happen, so that the vines of late varieties are rarely killed before a frost. This makes it doubtful if spraying as a yearly operation pays here. The fungus is known only in its conidial stage. It produces at first discolored but finally small, whitish spots with a darker border in which usually the spore receptacles can be seen as black, embedded specks. The elongated, septate spores ooze out from these and spread the disease. Very similar spots are also found on the stems and to a limited extent on the fruit.

We have been fairly successful in controlling this trouble by spraying small patches with Bordeaux mixture, keeping the vines fairly free until killed by frost; however, spraying is likely to delay the ripening of the fruit somewhat **and the late pickings are rarely so profitable as the early ones.** Where desirable, as in the case of serious injury that we have heard of on tomatoes grown occasionally for canneries, the spraying should begin before the fungus becomes prominent and be continued every ten to fourteen days according to the weather **conditions. The fruit should be picked just before spraying and if necessary** washed. Rotation of the fields should help since the fungus apparently can carry over in the infected rubbish.

Seedling rots, *Pythium debaryanum, Rhizoctonia Solani.* These fungous troubles are found occasionally, causing damping-off of seedlings in cold frames, hot beds and flats in greenhouses. *See* description of damping-off under Spinach and of the Rhizoctonia fungus under Lawn grasses and Spinach.

Sooty mold, *Fumago vagans.* We have seen this commonly on the leaves of greenhouse tomatoes (Rept. 1906:329) when the white fly or aphids were evident. *See* Apple.

Wilt, *Fusarium Lycopersici.* While at least thirteen species of Fusarium are said to occur on tomatoes, this is the one we use to designate the wilt trouble that is found in this state on both our fields and greenhouse crops. It causes a wilting, yellowing and dying of the leaves from the lower part of the plants upward. Cutting across the apparently healthy stems of the infected plants, one can see the fibrovascular bundles discolored reddish-brown and a microscopic examination reveals the presence of the mycelium and occasionally the spores of the fungus. Its presence gradually cuts off the water supply to the parts above, with their resultant death. Usually no external appearance of the fungus shows until the stems or portions of them begin to die or the fruit to ripen. Then a whitish growth of the mycelium, turning to a pinkish color with spore production, may appear.

We have found the mycelium in the fruit attached to the seeds and in this way, or internally in the seeds, the fungus carries over as well as in the refuse of the soil. No mature stage is known. Selection of healthy seed, the use of seed beds free from the fungus and rotation are the **preventive** measures for control of this trouble.

Nematode rootknot, *Heterodera radicicola.* This is occasionally found on the roots of greenhouse plants where it may cause considerable trouble. *See* statements under Cucumbers.

Growth cracks. This trouble shows around the stem end of the fruit rather than on the blossom end, as with the Point rot, and is more common on irregularly shaped than on roundish varieties. Cracks appear radiating outward from the point of stem attachment and if prominent are likely to hinder the sale of the fruit. Sometimes these cracks scar over but if they remain open certain **fungi may gain entrance and start rots. The type of the weather, the variety** grown and perhaps the fertilization, all apparently have to do with the trouble which, therefore, varies from year to year. Large and ill-shaped specimens are apparently most likely to show the trouble. **Complaints have been made of such** varieties as Bonny Best, Earliana, etc. *See* Snapdragon.

Leaf rolls. As with the related potato, the tomato shows trouble of this **nature due to weather conditions, lice and "virus" infection.** The first type seems to be the most common and least serious. *See* Potato for further information.

Lightning injury. So far the botanical department has examined injury of this nature to tomato vines only once, in 1931 at Branford. The injury was similar to that caused to the fields of potato. *See* also Tobacco for further statements.

Mosaic. As with tobacco, the tomato is subject to injury by this virus disease. On the whole, however, it is not so commonly and usually not so seriously injured by it. We consider the cause the same in each case, since the writer was able, years ago and apparently for the first time, to transfer the disease from mosaic **tobacco to healthy tomatoes and back again to tobacco. In some of our experi**ments with the mosaic on tomatoes in the greenhouse, we noticed a trouble similar to that described by "streak" which seemed to be of a bacterial nature thought by some to be caused by *Bacillus Lathyri* and by others to be connected with unbalanced fertilization. *See* Tobacco for further statements concerning mosaic.

Point rot (Blossom-end rot). This trouble has long been known on the fruit of tomatoes, beginning at the blossom end when the style falls off and leaves **more or less small cracks. It may finally extend to half of the green fruit as** a brown-black, somewhat sunken, dry rot. It has been laid to bacteria, *Macrosporium Tomato* described here and to dry weather, especially sudden, hot spells. Apparently lack of water is the chief cause since we were never able to isolate any suspicious germ as the cause. **The trouble varies greatly in different years and some varieties are more subject to it than are others.** It apparently can be lessened in the greenhouse by sub-irrigation and possibly in the garden by judicious watering and mulching. (Fig. 60.)

Scald. As a result of hot, dry weather, especially if it comes on suddenly, this trouble may develop on the more exposed surface of the fruit as a light-brown discoloration, often with withering of the skin and even with injury to the tissue beneath. It may also open the way for further trouble by fungi. *See* Apple.

Trumpet Creeper

Leaf blight, *Cercospora sordida.* This is the only fungus on *Tecoma radicans* **that has been found here and then only once, at Storrs in 1907.** It is evident on the under surface of the leaves as small, angular patches, of a sordid-brown color, that often run together. The upper surface of the infected leaves is discolored more or less yellowish to reddish-brown according to the age of the infection. No other stage is known and not much has been written concerning it outside of the original description and its distribution. It has been found

more or less common, chiefly east of the Mississippi but especially in the south. Apparently, so far, no treatment for control has been necessary.

Tulip

Botrytis blight (White spot), *Botrytis Tulipae.* *See* Addenda.

Crown rot, *Sclerotium Delphinii.* This fungus was found once on tulips causing a rot of their bulbs. However that year, 1933, the tulips blossomed in good shape since they had only recently been transplanted in the soil, where this fungus had caused injury the year before. *See* Larkspur.

Rhizoctonia (Gray bulb) rot, *Rhizoctonia tuliparum.* In the spring of 1932, the writer received, from a seed firm in the state, certain tulip bulbs that had been planted the fall before but had failed to come up in some cases and generally did poorly. These bulbs were more or less badly rotted and showed the presence of bacteria, yeasts and fungi in the rotted tissues; the one suspicious thing, however, was the sterile mycelium of one of the latter. This was evidently a Rhizoctonia which at the time we thought might be *R. Solani,* so common on the roots of a variety of plants. Later, reading Whetzel and Arthur's bulletin on the Gray Bulb rot of Tulips (Cornell Agr. Expt. Sta. Mem. 89) we decided the trouble essentially agreed with what they described as due to *R. tuliparum.* This, according to them, seems to have certain differences in the black sclerotia (as to their shape and microscopic structure) that form on the bulbs. No other stage is as yet known.

This trouble is apparently common to countries where tulips are grown for sale. Care should be used in purchasing good bulbs, especially avoiding those that show any signs of the black sclerotia on the exposed tissues. If trouble occurs plant in new ground with only healthy bulbs.

Tuliptree

Powdery mildew, ***Erysiphe Liriodendri.*** This is the only true fungous parasite, so far determined, on *Liriodendron tulipifera* in Connecticut. It has been found occasionally on seedlings in nature and on nursery trees. Only the conidial stage has been seen, though elsewhere its asco stage is occasionally reported. The mycelium and conidial spores are evident as an externanl, white growth on the leaves and according to some also on the young stems. We follow Burrill as to the specific name rather than Salmon who apparently places the fungus under *E. Polygoni.*

As yet this mildew has never been serious here and so needs no treatment.

Sooty molds, *Fumago vagans. Capnodium elongatum.* These black, saprophytic fungi, which perhaps are merely different stages of the same thing, have been found on the leaves and stems of this host growing on the honey dew of aphids. The first has been found chiefly on the leaves and is a conidial stage. The second has occurred on the stems and is the asco stage but so far as we have seen the evident, elongated perithecia are without asci or spores. Besides being unsightly, by cutting off the light, etc., on the infested parts of the plants, it does some secondary damage. *Look* for similar troubles here under Linden, White Pine and Apple.

Wood and bark rots. While this host is a rather common tree in our forests and is occasionally grown as a shade tree in the yards, we have received no complaints of any serious injury to its wood or bark of a fungous nature. We have listed half a dozen woody and fleshy fungi on it but these have all been found on the dead trees or branches as saprophytes. Perhaps some have caused rotting of the heartwood before the trees have died but if so we have no definite information as to their identity. Those found so far as saprophytes are as follows: *Daedalea confragosa, Fomes applanatus, Irpex tulipifera, Merulius tremellosus, Pleurotus sapidus* and *Polystictus versicolor.*

Turnip, White

Bacterial leaf spot, *Bacterium maculicolum.* This has been found rarely on this host, *Brassica rapa.* *See* Cauliflower.

Bacterial soft rot, *Bacillus carotovorus.* The bacterial soft rot has been found on the roots of turnips, rarely out of doors as well as on the stored roots. *See* Iris.

Black leaf spot, *Alternaria Brassicae.* This fungus has been occasionally found on the leaves of the white turnip as well as on other cultivated crucifers. Little damage is caused. *See* Cabbage for description.

Clubroot, *Plasmodiophora Brassicae.* We have seen clubroot more frequently on the white than on the yellow turnip but not so frequently on either as on some of the other related plants. In 1932 Dr. Dunlap, at the Station greenhouse and at our farm, mixed soil from fields infected with clubroot in the healthy soil and then planted seeds of the following crucifers: Broccoli, Brussels Sprouts, Cabbage, Cauliflower, Chinese Cabbage, Collards, Kale, Kohlrabi, Mustard, Radish, Rape, Rutabaga and White Turnip. All of these developed clubroot except the last two but the real reason for failure in these was not determined. *See* Broccoli for description and control of clubroot.

Downy mildew, ***Peronospora parasitica.*** This mildew causes a downy or scanty, slightly elevated, white growth of conidiophores and spores in patches, usually on the under side of the leaves. Its larger, thickwalled winter spores, oospores, are developed hidden within the tissues and so are usually difficult to find. While this mildew is not uncommon on certain of its hosts, it does not generally cause much damage. So far it has been found here only on the following cultivated plants: Broccoli, Cabbage, Mustard, Radish and White Turnip. Besides these it has also been collected on an even greater number of wild ones belonging to the Mustard family.

So far the trouble has not merited preventive treatment here on any of the hosts.

Powdery mildew, *Erysiphe Polygoni.* The powdery mildew, seen only in its conidial stage, has been found a few times on the upper surface of the leaves causing little injury. *See* Clover for further statements.

Scab, ***Actinomyces scabies.*** Sturgis reported this trouble as on both white and yellow turnips, especially on land previously infected with scabby potatoes, *q. v.*

White leaf spot, ***Cercosporella albomaculans.*** We have found this trouble once here on white turnip but not on the yellow though we collected it on the latter host in Massachusetts where is seemed to be more common. *See* Chinese Cabbage for description.

Aphid mold, ***Empusa Aphidis.*** In certain years aphids become very prominent on the under side of the leaves of turnips, as well as on some other plants, and cause much injury. With the advent of moist weather, the above fungus often gets started and kills great numbers of the aphids and thus, by their destruction, acts as a beneficial agent to the plant. This fungus develops its mycelium internally in the aphids and about the time of their death comes to the surface and produces spores that are shot off and on falling on other aphids cause their infection. A similar fungus is seen on house flies attached to windows by a white powder of spores. Besides the help from this fungus, it is sometimes desirable to kill the aphids by use of nicotine compounds, though it is difficult to get these insecticides to hit them on the lower leaves just above the ground.

Growth cracks. These sometimes appear at the top or sides of the roots. *See* Snapdragon.

Umbrella Tree

Chlorosis. The only trouble we have recorded on this tree, *Magnolia tripetala,* was described in Bull. 222, when in May, 1916, we received leaves from Southport showing a yellow-green mottling much like a mosaic trouble. However, this trouble of the leaves evidently came from injury to the trunk, possibly winter injury, which showed on the bark as dead places.

Valerian

Crown rot, ***Sclerotium Delphinii.*** We have found this fungus at least twice on specimens of *Valeriana officinalis* causing trouble; for description *look* under Larkspur.

Verbena

Powdery mildew, *Erysiphe cichoraccarum.* Occasionally on the leaves of these garden plants we find a slight development, of the conidial stage only, of this fungus. Usually no harm is done though on some of the wild species of Verbena the fungus is more common and luxuriant and the asco stage frequently is present. *See* Phlox.

Vetch

Leaf spot, *Ascochyta Viciae.* This fungus has been found several times spotting leaves of *Vicia villosa.* The fruiting receptacles are visible as minute, black bodies embedded in these spots. If abundant the leaves die prematurely and even the pods are said to become infected. So far the trouble has not been bad as the vetch is only occasionally grown, chiefly as a cover crop. Apparently no mature stage has been found unless it is really the same species as that on the pea, as some believe, in which case it is connected with *Mycosphaerella pinodes.*

Rust, *Uromyces Fabae.* So far this rust has been found here only on wild species of *Vicia Cracca,* though in England we collected it on *V. Faba,* so it is likely to appear where that species is occasionally grown here.

Violet

Anthracnose, *Colletotrichum Violae-tricoloris.* While we mentioned this in our 1903 report as occurring occasionally on the leaves of *Viola odorata,* we saved no specimens and have not collected it in recent years. It has been found more frequently on the Pansy, *q.v.,* where it sometimes causes rather severe injury.

Black root rot, *Thielaviopsis basicola.* Thaxter in the 1891 Rept., page 166, was one of the first, if not the first, to report this trouble on violets grown in greenhouses and outdoors. It has been found occasionally since by others here. It attacks the roots and causes a sickly, yellow growth of the foliage and if severe may also stunt the growth of the plants.

The soil becomes infected so that this should be changed, sterilized, or new ground selected when other plants are again grown. *See* Tobacco.

Leaf spots, *Alternaria Violae, Cercospora Violae,* and *Phyllosticta Violae.* These three very similar leaf spots attack chiefly sweet violets, *V. odorata,* though some of them as well as *Septoria Violae,* have been found on the wild species. For treatment *look* under Pansy.

The first species has been by far the most serious and, during moist or foggy weather, has caused serious trouble in certain greenhouses, especially those along the Sound. It produces very definite, white, round spots, usually one-eighth to one quarter of an inch in diameter with a darker border. The first two of these imperfect fungi produce conidiophores and spores, the first dark and the second light colored, on the surface of the infected spots. The last fungus has its spores embedded in small, black receptacles within the invaded tissues and so far has been only rarely reported here, being first seen by Thaxter.

Rusts, *Puccinia ellisiana, P. Violae.* Both of these rusts have been collected only on wild species of violets in this state. The first rust is a heteroecious form having its aecial or cluster cup stage only on the violet. The second is much more common, is autoecious (all four stages on the violet) and occurs on a number of different species. Since these wild violets are being more commonly cultivated, it is quite likely that the second rust may eventually be found in our gardens. In fact since the above was written, we found it common on *Viola odorata* in a famous garden in Fairfield.

Speck anthracnose, *Marssonia Violae.* This trouble has been seen only once, having been sent from Niantic in 1906 on wild species of violet cultivated in a garden. In this case it could easily be distinguished from the preceding leaf spots by the small, speck-like, invaded tissues as well as by its spores. Where abundant in the leaves it causes a yellowing of the same.

Virginia Creeper

Black rot (Leaf spot), *Phyllosticta Labruscae.* This imperfect fungus is often found causing round, brown spots more or less abundantly on the leaves of *Ampelopsis quinquefolia.* It also occurs on the Boston Ivy and Grape. *See* these for further details.

Powdery mildew, *Uncinula necator.* This mildew is not uncommon on both this host and the grape, usually causing more injury to the latter. The white mycelium and powdery, conidial spores develop externally on the surface of the leaves and to some extent on the young stems and fruit. If the plants are attacked early and vigorously, then some damage may occur by the death of the invaded tissues but ordinarily the injury occurs so late in the season that the injury is of minor importance here. The small, reddish to black perithecia can be seen developing in the fall attached to the mycelium. They are very interesting, as seen under the microscope, because of their hooked appendages from which the genus takes its name.

Where necessary spraying should control the trouble if started in time.

Walnut

Anthracnose, *Marssonia Juglandis.* This has been found here on *Juglans nigra,* on which it is our most common leaf trouble, and rarely on *J. regia.* It also is found on the butternut, *J. cinerea,* where that occasionally occurs. The injury is evident on the leaves as medium to large spots or blotches of reddish-brown, dead tissues. The fruiting stage can usually be seen as flattened, black, embedded bodies especially on the upper surface of the leaves. It is an imperfect fungus.

No spraying experiments, so far as we know, have been tried but such treatment has been suggested. The asco stage is said to be *Gnomonia leptostyla,* found on the old dead leaves, so this should be gotten rid of in the fall by raking up the leaves.

Black rot, *Sphaeropsis* **sp.** We found this fungus once on the branches of an English walnut, *J. regia,* at a private estate at North Stamford in 1924. It seemed to be acting as a parasite or possibly was merely following winter injury to the branches. Dr. McCormick obtained cultures and in the successive renewals made it produced spores easily which seems to distinguish it from the ordinary cultures of *S. malorum* from apple. Its sori on the branches also seemed to be larger and more elevated than with that species.

White mold, *Microstroma Juglandis.* While we have listed this fungus on the above host, we lack a specimen. However, it has been reported from a number of other states and no doubt occurs here. *See* Butternut and Hickory for description.

Watercress

Leaf spot, *Cercospora Nasturtii.* Watercress, now known as *Radicula Nasturtium-aquaticum,* is gathered for sale as a garnish for food. It is not really cultivated but is sometimes transplanted in slow streams to be gathered as needed. The above fungus is the only one so far found here on the plant. It forms rather distinct, whitish spots with usually a scanty development of the conidial stage as an external growth. The chief objection to it is that it may spoil the looks of the foliage for decorative purposes.

Watermelon

Anthracnose, *Colletotrichum lagenarium.* Watermelons, *Citrullus vulgaris,* are not grown here so commonly as formerly. Certain of our sandy soils seem adapted to their growth but their lateness in ripening and competition with those grown farther south have discouraged their production. When grown here their chief trouble, as far as we have seen, is this anthracnose. It develops as small, angular spots on the leaves but is most evident on the fruit as sunken places of varying size that when abundant may spoil them for sale. Generally the evident ooze of the pinkish spores can be found on these rotted spots. This same trouble has also

been found on cucumbers, gourds, muskmelons, pumpkins and squash. In 1932 it was very injurious to Michigan squash where its appearance was somewhat different on the fruit. (Fig. 61.)

These crops should be rotated with others to lessen the trouble and, if necessary, spraying with Bordeaux should start before the appearance of the anthracnose. In the early treatment, attention should be paid to coating the fruit, using potassium oleate as a sticker and spreader where necessary.

Black mold blight, *Macrosporium cucumerinum.* We have found this fungus occasionally on the leaves of watermelon, but never causing as much injury as on the muskmelon, *q. v.*

Downy mildew, *Peronoplasmopara cubensis.* This fungus was found here once or twice in the past but it did not cause much harm to this host; however, it has been found frequently and causing much damage to muskmelon, *q. v.*

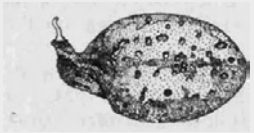


FIGURE 61. Watermelon anthracnose.

FIGURE 62. Wheat loose smut.

FIGURE 63. White pine blister rust.

Fruit rot, *Pythium* sp. A Pythium has been found only once on watermelon, grown at the Station's Mt. Carmel farm in 1931. There in August were seen a few melons before maturity that were rotting from a fungus of the *Pythium artotrogus* type with spiny oogonia. The same or a similar fungus has been found once or twice on rotting seedling lettuce.

Wilt, *Fusarium* sp. We have never collected specimens of watermelon vines that had died from a Fusarium wilt, though we have occasionally seen such a trouble on muskmelons, but have heard once or twice of its probable occurrence here on watermelons. Since watermelons are so rarely grown in the state today and since the growers usually practice rotation, little trouble may be expected here. . However in the Mississippi Valley, a Fusarium wilt has proved very serious in many fields. In 1931 and 1932 we obtained seed of three varieties of melons from Iowa that were said to be resistant to this trouble and they were grown in several places in the state but neither they, nor other varieties reported, showed any signs of a wilt due to a Fusarium. If melons were grown here year after year with little or no rotation, there is no reason to doubt that this trouble would develop and become serious once it got established in the soil. In such cases a wilt resistant variety would be valuable.

Wheat

Glume-leaf blotch, *Septoria* sps. Only rarely, when especially sought, have we seen a fungus of this genus on the glumes and leaves of wheat, *Triticum aestivum,*

and then it has been so inconspicuous as to cause little injury. The discolored spots show the fruiting stage as small, black, embedded bodies. There have been several species of Septoria listed on wheat and often those on the glumes and leaves are considered as distinct but we have made no special studies of those found here.

Wheat, while it has been grown here more or less extensively in the past, with a slight revival during the world war, is now very rarely found on our farms. For this reason none of the troubles, often very serious in the fields in the west, prove very harmful in Connecticut.

Powdery mildew, *Erysiphe graminis.* This fungus has been found occasionally on this host but never so prominently as on Rye, *q. v.*

Rust, leaf, *Puccinia triticina.* When wheat is grown this rust has been found more or less conspicuous on the leaves and sheaths in its II and III stages. The dusty, uredo sori break open as small, oval, orange blisters in the early summer and are succeeded later by the lead-colored, embedded, telial sori, long covered by the epidermis. Our specimens, however, are confined chiefly to the II stage. The I stage, said to occur on Ranunculaceae, has not definitely been associated here with the rust on wheat but, by some, our wheat rust is not considered distinct from *P. Clematidis,* which has a wide range of hosts for both its O-I and II-III stages and is found here in all stages on several of its wild hosts.

Rust, stem, *Puccinia graminis.* While this rust has been found here very frequently on wild or escaped plants of timothy and redtop, it has rarely been found in recent years on wheat though in the west it is one of the chief threats to this crop. However, it apparently was abundant here on this crop during the latter part of the eighteenth century, as shown by the quotation given under Timothy.

Scab, *Fusarium culmorum.* This fungus has occasionally been seen as a pinkish growth on the heads of wheat but causes little damage. *See* Rye.

Smut, loose, *Ustilago Tritici.* This is one of the most common troubles in wheat growing districts since it directly destroys the seeds and glumes, changing them into dark, dusty masses of spores held together temporarily by the remains of the flower tissues on the spikes. Often the grain destroyed reaches a high percentage but in Connecticut this rarely reaches over one or two per cent. (Fig. 62.)

Seed treatment in its modified form, therefore, has never been advantageous here.

Smuts, stinking, *Tilletia laevis* and *T. Tritici.* Both of these smuts have been found a few times in our occasional wheat fields, the first more commonly, but neither has caused any serious injury so far as we have seen. They develop in the modified, slightly swollen seeds which are hidden in the glumes of the head. When broken open these infected seeds show a brownish mass of spores having a fetid odor. The two species differ in their spores, the first having smooth and the second reticulate walls.

One of our chief complaints has been with the sale of ground foods for animals, sent in from other states, where badly smutted wheat has been used. In some cases sickness of the animals has been laid to this food but we have never been able definitely to blame it on the smut spores.

These smuts when present can usually be controlled by various seed treatments, though in some regions the spores seem to pass the winter in the ground and so help to infect a new crop grown there. Copper sulphate, hot water, formalin and dust treatments have been used at various times as the fungicides to kill the spores on the seed before planting.

White Pine

Blister rust, *Peridermium Strobi. See* Addenda. (Fig. 63.)

Butt rot, *Polyporus Schweinitzii.* This semi-fleshy to corky, large Basidiomycete has been found a number of times at the base of dead trees or on logs of conifers, especially those of white pine. We have never been sure, however, that it was responsible for their death though it is classified as a root parasite by some

authorities. In fruiting it forms chestnut-brown (lighter colored when young and darker in old specimens) sporophores with a spreading cap (sometimes with more than one overlapping or irregularly placed cap) on a short, central or eccentric stem. The under side of the caps show large, thin-walled, honeycomb-like pores. The mycelium is said to produce a red-brown rot of the heartwood of the roots and base of the trees.

Needle cast, *Lophodermium lineare.* We have several times collected specimens of a fungus on the needles of white pine that seemed to be responsible for their death and which we have identified as the above species. At times part or the whole of one or more needles of the whorl turn reddish-brown while the remainder show the normal green color. On these dead areas frequently appear the oblong to linear (often fusing and running the length of the needle), elevated, black, fruiting receptacles of an Ascomycete which eventually open by elongated slits. The spores when seen are linear, rather than oblong, and so are more like a Lophodermium than a Hypoderma as this one was originally called. The fungi of this general type on various conifers, however, need further study as to their exact identity and possible parasitism.

Root rot, *Fomes annosus.* In our report for 1906, page 320, we mentioned a trouble of white pine in a plantation at Windsor where some of the trees in the low ground blew over, sometimes before they had died, in different years. This was evidently due to their weakened and rotted roots. While we could find the mycelium on the roots of the fallen and usually dead trees, we were not sure whether their death came from it or was the result of winter injury to the roots, as there was no sign of the fruiting stage of the fungus. More recent examinations disclosed this on the roots, usually hidden by the soil, and it turned out to be the fungus given here. So far this is the only place where it has been found in the state. However, elsewhere in this country and in Europe, the fungus has been reported on various conifers and it is regarded as a true root parasite. We do not know whether any experiments with mycelium inoculated into the roots of healthy trees have proved its parasitism, and what, if anything, weather conditions unfavorable to the roots have to do with its development and destruction of the root. The mycelium develops conspicuously beneath the outer root covering and penetrates deeply into the woody tissues causing evident and characteristic rotting.

The fungus usually develops rather thin, or sometimes thicker, leathery to woody fruiting-bodies on the hidden roots, with their upper surface dusty to reddish-brown and somewhat velvety, and the lower with rather even, white pores. These sporophores are usually irregular and often develop with the upper surface attached directly to the surface of the roots, giving an inverted appearance. This Basidiomycete is perennial and with the thick specimens one can see indications of the pores in layers on cutting across. So we have placed the fungus under the genus Fomes rather than Polyporus, where it was originally described, or *Trametes radiciperda* which is considered a synonym.

Seedling rot, *Rhizoctonia Solani.* So far as we have seen, this has been the chief cause of the damping-off of seedlings of this and other conifers in the state. *See* statements under Pines, Potatoes and Spinach. In one unusual case (Report 1915, p. 450) after the seedlings had passed the damping-off stage, we found this fungus by its mycelial strands creeping up on the outside of the stems to the needles which it killed by penetrating their tender tissues at their sheathed base.

Sooty mold, *Capnodium Pini.* This fungus has been collected by us and also sent in for identification a number of times when it was causing injury to the needles of the white pine. Sometimes only the mycelial or conidial stage was showing as an evident, superficial, black growth on these and the young stems. Occasionally this growth had developed to form a very luxuriant covering with the numerous, elongated and pointed fruiting bodies reaching out to about 2 mm. in length on the leaves and even 4 mm. on the stems which are characteristic of the Capnodium fungi. So far, however, we have not seen mature asci or asco spores developed in these bodies. While the fungus is a saprophyte, developing

in the honey-dew secreted by aphids on the trees, there is little doubt that this growth, by its black color and luxuriant coating, cuts off the light to the chlorophyll of the leaves and thus causes injury.

The remedy is to prevent its development by killing the aphids, an entomological treatment. *See* Pine, Bull. 344, p. 144.

Doubtful parasitic fungi. Besides the above fungi we have listed on stumps, logs and branches of white pine various fungi which while they may cause decay of the dead bark and wood we have never or rarely seen on the living trees. Certain of these, however, have been listed by some writers either as parasites or heartwood destroying fungi. Of these we mention here but three:—

Trametes Pini is a very variable Basidiomycete. It is sometimes thick and hoof-shaped with a variously rimosed, cracked, blackened upper surface and sometimes a comparatively thin, resupinate form with at first a reddish-brown, hairy surface. But always it has a cinnamon-brown interior and a similarly colored, poroid, fruiting surface with fairly thick partitions between the pores. We have found it here rarely on dead tissues and only once on a living tree. It is said to cause a rot of the heartwood.

The second Basidiomycete is a lower form, called *Septobasidium pinicola*, that is occasionally sent in for determination as a possible parasite. Usually we have found it on the smooth, green bark where a branch has been cut off. It seems to be merely a saprophyte developing on the exuded material or, in some cases, on the dead insect scales but in no case have we seen any evident indication of injury to the living bark. It forms a loose, felt-like, reddish-brown, somewhat roughened or pitted sporophore adhering directly to the bark.

Scoleconectria scolecospora is an Ascomycete that develops on twigs or on larger branches as cankers, and forms clustered, dark-red, small, egg-like perithecia similar and related to those of Nectria. We have sometimes associated it with possible blister-rust cankers but usually we have seen it on dead twigs or branches where it seems to be a saprophyte rather than a parasite. However, by some it has been classed as the latter under the name of *Nectria* (*Chilonectria*) *Cucurbitula.*

Ant cankers. Since pine plantations have been set out in our sandy soils, one can find spots where the young seedlings up to a fair size are missing or dead and in the center of these circles, twenty to fifty feet in diameter, can be seen a large hill or nest formed by red ants. Occasionally on the bark of these dead pines could be found the fruiting stage of a Phoma (Rept. 1912, p. 354) and it was a question at first whether or not the trees had been killed by a parasitic fungus since at least two species of this genus are reported from Europe as injuring conifers through canker-like growths. Later investigation, however, has shown that the trees were killed by the ants, possibly in some cases through chewing, but more certainly by injection of formic acid into the young tissues of the bark. These ants usually build their nests in more open places and the shade from the pines, as they developed, apparently proved objectionable.

Blight. Needle-blight is a general term applied to pines, particularly white pines, in which certain or all of the last or this year's needles on a tree show a reddish-brown discoloration from the tips inward to a greater or less extent. If the injury came early in the season of their growth, then the needles are stunted and more or less bunched on the branches. Efforts were made at first by some to show that this injury was the result of parasitic fungi, since growths of these sometimes showed somewhat on the dead tissues. Our experience in this state, however, has been that we have never found any fungus consistently on the leaves as a possible cause and usually they are devoid of any such growths. Loss of water from the needles and failure to be supplied sufficiently from their roots or direct injury to the leaf tissues or their roots are the immediate causes of the trouble.

The writer was one of the first in this country to call attention to this trouble in the Report for 1907, p. 353, and again in 1909–1910, p. 720. The summer of 1907 was dry and hot and the needles were apparently injured chiefly from these conditions. At other times we have seen injury due to severe winters, late frosts, summer-like weather in late winter when the ground was frozen, sudden hot

spells in early spring following wet or muggy weather, drying out of the roots on improperly transplanted trees and rarely to direct injury through fumes from brick-yards. All of these are so-called physiological or environmental types of injury. If severe the trees may show the trouble year after year and become dwarfed or even die. If the injury is slight and non-recurrent, then the trees usually regain a healthy appearance upon the production of new leaves and the loss of the injured ones.

Care in planting, watering in dry weather and possibly some fertilization are the only partially preventive or remedial measures for troubles of this sort.

Drought injury. *See* **preceding article.** We have also seen trouble in the seed beds in dry years after very hot periods especially if the seedlings were not watered or protected by a proper screen.

Fertilizer burn. While fertilizers are not used extensively on these seed beds, we have seen one case where the fertilizer (said to have been ground bone?) was sprinkled on one-year old seedlings wet with dew with the result that the leaves were burned, though the same treatment later in the day on seedlings with dry leaves produced no harm. Ordinarily where a fertilizer is applied to any seed bed, the sediment should be washed off the leaves at once.

Leaf and Stem yellow spots. The first of these appear as small, yellow spots on the leaves, often on several in the bunch at the same height, thus suggesting a common cause. As we have found insect scales on the leaves that later disappeared, we believe that these spots are often caused by their punctures. However, these spots are occasionally so similar to the yellow spots caused by blister-rust infections that sections of the needle-spots should, in such cases, be made in order to be sure of their real cause.

The second mentioned yellow spot, on the one or two year old stems, is much more evident as to color and size, often centering from the base of a needle bundle which also may be yellowed at its base. When studying blister rust infection some years ago, we at first thought that this might be one way in which the fungus gained entrance directly to the stems but sections always failed to show any signs of mycelium in them. On young stems of the pines in certain years, we often find spittle bugs and these seem to be the most probable cause of these spots but, if so, the injury does not appear until some time after their disappearance.

Lightning. We mentioned and showed a photograph in Bull. **263,** p. 177, of a white pine at Cornwall that was struck by lightning in 1917. It showed no evil effects afterwards other than the natural stripping off of a few limbs and an evident, torn streak down the trunk to the ground. We have seen other trees apparently similarly injured. On the other hand we have known of certain trees where the results of lightning injury have been fatal and this probably also occurs with conifers under similar conditions. Just what these conditions are, we are not sure as yet, though some writers have offered explanations, but evidently the cambium is killed in such cases.

Mice girdle. This sometimes occurs in plantations when snow long covers the ground. *See* Pine.

Snow bend. In young plantations especially when heavy snow falls on the trees and sticks there for some time it makes a more or less permanent bend of the young trunk which later assumes gradually a natural, upright growth from the bend.

Winter injury. Winter injury or death sometimes occurs to trees, especially in low wet spots, and also to seedlings when not properly protected. Later in the season it may be hard to determine the cause of the injury if the trees are dead.

A different type of injury is frequently shown in the green bark of the trees which turns prematurely reddish-brown in spots like that of the older bark. Often this does not reach the cambium so that the trouble may be outgrown but its presence in the green bark may suggest to some a fungous type of injury but without evidence of a definite fruiting stage.

Witch's broom. We have seen at least one case in a plantation where the branch or terminal trunk made a condensed growth of aborted branches closely pressed together and covered with leaves. In this case the broom was not due to fungi but we have no good explanation for it unless slight winter or insect injury may have been responsible.

Willow

Anthracnose, *Physalospora Miyabeana.* In recent years this fungus has been found on willow twigs and leaves and with the scab has been partly responsible for great injury to cultivated willow trees both here and in northeastern United States and Canada. While we believe most of the killing of the very young leaves in early spring, resulting after several years in the death of shade trees of *Salix alba* var. *vitellina,* can be more directly attributed to the scab, we find the anthracnose fungus also kills the young leaves when infected artificially and is not uncommon later in nature on the older, living leaves and twigs.

Dr. McCormick has grown cultures of the anthracnose from this state, Canada and Japan (where the fungus was originally found) and we are not sure that it is really distinct from bitter rot, *Glomerella cingulata,* found on various hosts, though we keep it separate here since there seem to be some slight differences. In cultures the Physalospora is variable, especially in the color of the mycelium. It forms pink exudations of its conidial spores chiefly on the lighter-colored, young mycelium but when more of a dark growth appears one is likely to find perithecia with ascospore development. Cultures from single spores, as well as general cultures from here and Japan, have eventually developed the asco stage.

On the whole the writer believes this fungus, while possibly more of a strict parasite than the scab, causes most of its injury later in the season. We find it on the older, mature leaves, but especially on the twigs in the fall, both in its conidial or Gloeosporium stage and its asco or Physalospora stage. In the spring both before and after the beginning of leaf development, we have found the conidial stage of the scab on the dead and injured twigs as the apparent chief cause and source of infection and death of the young developing leaves. *See* later statements under Scab in the Addenda.

Crown gall, *Bacterium tumefaciens.* This bacterial disease has been found a number of times, chiefly by nursery inspectors on the roots or base of young trees, but it does not seem to cause much damage. Usually the species of the willow is not known but *Salix babylonica* and *S. nigra* are two that have been reported definitely. *See* Rose.

Heartwood rots, *Fomes applanatus, Trametes suaveolens.* The fruiting stages of these two Basidiomycetes have been found on living trees of *Salix alba* var. *vitellina* causing rot of the heartwood. *Fomes applanatus* is a common, heartwood rot of trees (especially maple, *q.v.*) but it is not commonly found fruiting on them as it is on their stumps and logs. It is our largest and most common of the woody fungi. It develops a rather flat, hard, evident sporophore light to dark brown in color on its upper surface and minutely poroid and usually white on the lower. It is attached to the host on one side and the mycelium from which it develops is found causing a white rot of the heartwood. The fruiting bodies may vary from a few inches to two feet across the attached side. If old it shows concentric rings of development on the upper surface and annual, superimposed rings of growth when cut across its fruiting surface. The white, lower surface is easily marred and so is made use of for etching.

Trametes suaveolens is another poroid fungus but in this case the fruiting body is more corky and often develops overlapping or irregular fruiting bodies also attached at one side directly to the host. Their surface is smooth and somewhat velvety to the touch and rather evenly colored all over from a light yellow-brown to a dusty-brown according to age. The poroid surface when young has rather thick dissepiments but with age these are thin with rather large pores between. One of the chief characteristics of the fruiting bodies, however, is the rather sweetish or anise-like odor.

Powdery mildew, *Uncinula Salicis.* Like the other powdery mildews this one forms a more or less evident, white coating, often in spots, on the leaves usually on their upper surface. The small, black perithecia, maturing later in the season, have numerous hooked appendages as seen under the microscope. On certain wild specimens collected by Thaxter, the perithecia show by the thousands scattered, or more or less grouped, over the leaves. However, this mildew is not usually bad enough on cultivated trees or shrubs to need much attention.

Radiating fungus, *Asteroma Capreae.* This fungus is apparently only a weak parasite appearing on the old and often languishing leaves of the willow in the fall. It produces evident, discolored blotches on them that at first are brownish but later become black through the evident, radiating, dark mycelium growing on their upper surface. This mycelium is something like that of apple scab in that it is evidently produced just beneath the cuticle. It is said that the fruiting stage has not been observed but some of our specimens show immature fruiting bodies at the center of the spots, especially on the older leaves that were shed on the ground. It is quite possible that the fruiting stage matures on these later and is an Ascomycete. We saw a few hyaline, oblong spores much like Physalospora that possibly were connected with its fruiting stage, but we were not sure how they were borne. Asteroma is placed with the imperfect fungi.

We have made only two collections of this fungus though it is probably not rare. One was on cultivated basket willows, labeled Lemley at the Mt. Carmel Station farm, and the other was on wild specimens of *S. cordata* obtained the same year, 1928, at Morris. Seymour does not list this fungus from North America although he does list *Asteroma Salicis* on Salix sp.

Rusts, *Melampsora Humboldtiana* (*M. americana*), *M. Bigelowii.* These rusts are not uncommon on native trees and shrubs but are not so frequently seen on the cultivated ones. They need little attention other than care in avoiding planting too close to alternate hosts that harbor other stages of the rusts and in raking and burning their leaves in the fall when these have become infected.

The alternate hosts for the I spores are *Abies balsamea* for the first, so far never seen rusted here, and *Larix laricina*, presumably rusted here in the northern part of the state but yet to have its identity and relationship proved. These two alternate hosts produce the I stages as rather inconspicuous, Caeoma-like outbreaks on the leaves. Their spores carry the rust to the various willows on which soon appear the II stage.

The II sori show as small, yellowish, dusty pustules chiefly on the lower sides of the leaves. These are the repeating stages. Late in the season the III stages develop as larger, dark-red blisters embedded permanently in the leaves and their spores, on germinating, carry the rusts early in the spring back to the alternate hosts. These two rusts on the willows are so similar that they usually need microscopic examination to distinguish them. While *Salix cordata, S. nigra* and *S. sericea* have been identified as hosts for the first species mentioned, most of our collections have been determined merely as on Salix. These species are closely related to similar rusts mentioned here on poplar.

Scab, *Fusicladium saliciperdum.* *See* Addenda.

Stem canker, *Septomyxa exultata.* This is a trouble worked on by Dr. McCormick. It was first sent to our laboratory by Metcalf of the U. S. Department of Agriculture from Iowa specimens and has since been received from a tree surgeon from New York state and has been found once or twice in Connecticut. It does not seem usually to be a very vigorous parasite on most of the willows. On a variety of golden weeping-willow, however, Dr. McCormick's inoculations were successful, producing red-brown injuries on the bark with fruiting bodies in a short time but on the other species there was only a slight infection or failure. *See* Bull. **337,** p. 462.

Aerial roots. This abnormality was seen at Old Lyme Shores in the fall of 1930 on young willow trees that apparently had been severely injured by the preceding winter so that the bark was killed in areas of varying size. The cambium in some cases, however, had formed new bark at the edges of the cankers. It was beneath the dead but still adhering bark that the trees were forming these short clustered roots in certain places in an effort to overcome the injury. None of them had succeeded in reaching the ground at this time. *See* Elm.

Wisteria

Canker, *Tubercularia vulgaris.* This conidial stage of the questionable parasite *Nectria cinnabarina* has been found on injured parts of this host. *See* Horse-chestnut.

Crown gall, *Bacterium tumefaciens.* While we have seen the above and certain unidentified spots on the leaves, the crown-gall is the only definite parasite we have listed on the stems of this climbing plant, *Wisteria chinensis.* Apparently even this latter is rare, since it was found only twice, first by a nursery inspector in 1912 on plants imported from Japan. *See* Rept. **1912,** p. 388; also Rose in this publication.

Yew

Damping-off, *Rhizoctonia Solani.* In certain of our nurseries in the past it was claimed that, because of the damping-off caused by this fungus, it was very difficult to grow seedlings of *Taxus cuspidata* in their beds. *See* Potato, Pines, and Spinach.

Oedema. We have had one or two complaints from a nursery of trouble on the young stems of Taxus showing small ruptures of the tissues without any evidence of a fungus or insect causing the same. Recently another observer has reported to us a case of similar trouble on plants in a cemetery where they had been cut back but the next year, when they were not so cut back, the trouble did not appear on the new growth. It seems to the writer that this reveals the explanation, since the normal transfer of the water from the roots to the leaves could not be properly regulated by transpiration when the foliage was largely removed, with the result that intumescence or oedema cracks appeared. *See* Glorybush.

Yucca

Leaf spot, *Cercospora concentrica.* This was reported twice in 1929 by one of the nursery inspectors but, as apparently no specimens were collected, we mention it here only as a possible trouble. There is no doubt that this or some other fungous leaf-spot was observed. Though it is the only fungus yet reported on this host here, elsewhere in the United States a total of over a dozen species have been reported as either saprophytes or parasites on *Yucca filamentosa* alone.

Frost-Growth cracks? In June, 1933, Mr. Zappe of the Station brought for examination the flower stalk of a yucca which he obtained from a nursery at Rockville. The injuries showed something like linear insect punctures but no evidence of the insect was evident and our entomologists knew of no similar injury caused by insects. The best guess we could give was that when very young the flower stalk had been hit by a frost, with some moisture present on the stems, and this slight injury had been accelerated soon afterward by unusual fast growth stimulated by favorable hot weather. Both of these conditions prevailed that spring. The evident, elongated, roughened tissues showed a callus-like, corky growth with cross splits of the epidermis reaching from the base of the secondary flower stalks and running downward, often to a point, one or two inches below on the main flower stalk. The scales at the base of the flower branches were dead apparently from the frost and a few of the stems of the lower branches showed this streaking effect. Apparently all the rest of the side branches had not been developed far enough to be exposed to the injury from the frost.

Zinnia

Drop rot, *Sclerotinia sclerotiorum.* This fungus was isolated once in 1930 from plants of *Zinnia elegans* where injury was being caused. *See* Lettuce.

Powdery mildew, *Erysiphe cichoracearum.* This has been seen frequently in late summer and fall forming a white, usually scanty growth of the conidial stage

on the leaves, especially on their upper surfaces. It was only once, in October, 1932, that it was found producing mature perithecia and the asco stage. *See* Phlox.

Leaf spots. There have been two leaf spots caused by Cercospora reported in the United States on this plant. We have occasionally seen roundish, discolored spots on the leaves in gardens in this state but so far we have been unable to find a fruiting stage of a fungus that we could definitely associate with them as the probable cause.

Mosaic. Only twice have we seen mottled leaves on this plant, and, while no experiments were conducted to prove their infectious character, the trouble looked like a true mosaic. *See* Tobacco.

Field of Potato Plants Killed in Less than a Week by the Late Blight in July, 1902

ADDENDA

Under this heading are included some of the larger articles originally placed under their proper hosts in the main body of the paper. Most of these include special work that the writer has done on these diseases or injuries, while a few relate to those new or unusual to him or of special importance because of recent outbreaks in the state. They are referred to in the main paper, therefore, merely by title.

Ash

Canker, etc. This trouble is included here because of complaint of certain tree men who seem to think that a definite fungus is responsible for cankers on the limbs and a general unhealthy condition of white ash trees. Personally we have not studied the problem other than to see some of the cankers and trees complained of in this state. Outside of the cankers, which may have come from injury by a fungus or insect, we are inclined to believe that the trouble, which has been reported as evident and often serious in the eastern part of the United States and Canada, may also be connected with recent unfavorable drought and perhaps winter conditions, resulting in poor growth of the leaves and a general premature killing of the twigs. The cankers start as small, swollen places in the bark of the twigs but eventually rupture and become prominent, empty, sunken cavities down to the wood. Rarely fruiting pustules, probably of different kinds, are seen on the cankered tissues.

Marshall in 1930 Proceedings of the National Shade Tree Conference gives a more detailed account of this trouble and the possible fungus that is thought to be its cause, and from him we have furnished Dr. McCormick with Connecticut specimens for a preliminary study. She, like Marshall, was able to isolate from around the cankers a fungus of the Macrophoma type (spores elongated, hyaline and single celled) but Marshall apparently got more variable or varied growths in cultures including Sphaeropsis and Diplodia as well. Seymour lists a large number of synonyms including all of these genera for presumably the same fungus. So far, apparently, no one has selected out a definite fungus and proved its parasitic nature on the ash by inoculations. This trouble, therefore, needs more definite study to show its nature. We have seen rarely isolated spots on leaves of ash trees where a true species of Sphaeropsis, similar to *S. malorum*, was fruiting.

Asparagus

Fasciation. The abnormal, flattened and thin stem of the main stalk, with divided and recurved tips, is usually characteristic of the type of trouble known as fasciation. This has been seen here occasionally in different years. One of the best specimens we have is several feet long, makes a complete turn on itself, bears numerous small, normal branches and its flattened sides are about three inches wide compared with a thickness of about a quarter of an inch. Such troubles have been associated by some with injury by insects, fungi, winter or by pressure on the growing tip of the plant. Our efforts some years ago to produce a similar trouble by pressure of stones against the growing tip of asparagus as it emerged from the ground were not successful but were too limited. In the examples we have seen on this or other hosts we were never able to trace the injury definitely to a fungus or insect. Failure of the leaf scales to properly open and so cause pressure or winter injury to the growing tips may be possible causes in some of the cases we have seen. Besides on asparagus we have seen very similar injuries on apple, bush-clover, chestnut, larkspur, peony, red maple, rose, spirea, sumac and a few wild plants.

In the spring of 1933 the writer tried various methods of injury to the growing tips of asparagus sprouts (2 to 12 inches high) as they grew in the Station's bed to see what effects resulted in the subsequent growth of the stems. The sprouts were treated, chiefly at the extreme tips, in the following ways: (1) tips bound permanently by flattened sticks or spring clothes-pins; (2) tips cut lengthwise by a sharp knife; (3) tips punctured vertically by a needle three or four times; (4)

same as (3) but punctured horizontally; (5) tips both cut and punctured: (6) tips pinched by the fingers; (7) tips just emerging from the ground stepped on; (8) stems below tip bound by a wire.

Thirty such treated sprouts were then left for growth for two to four weeks before they were cut and examined for injuries. Two of the sprouts were dead and a few made a slight but abnormal growth. Most of them, however, grew fairly well from two to six feet tall. We had hoped to produce at least one typical, fasciated stem but none showed such a result though we did find one such in the bed which had received no special treatment. We did, however, get a variety of abnormalities in practically all of the treated plants, most of them including more than one of the following: (1) zigzag growth of the main stem, seven cases; (2) coiled tip, four cases; (3) divided in two coiled tips, two cases; (4) coiled tip and then with straightened upward growth, one case; (5) curved and then straightened growth, six cases; (6) openings in the stem which grew together again, five cases; (7) creasing of the stem on one or both sides, five cases; (8) flattening of the main stem or branches, mostly moderate to slight, eleven cases; (9) slight bend of main stem, two cases; (10) slight deformity or swelling, two cases.

Most of the injuries of the thirty treated sprouts were made by pinching the growing tips with the fingers (fourteen cases) either moderately or severely. It seems to the writer that injury by stepping on the young sprouts, just before or after emerging from the ground, might account for fasciation or other deformities of this plant, though we did not reproduce greatly flattened stems in this experiment. In the two cases where the emerging sprouts, one or two inches above the ground, were stepped on, they showed only a slight growth but with a complete coil at the tip.

Cherry

Brown rot, *Monilia cinerea.* Of all the fungous diseases, this ranks among the ten most injurious here, being specially bad on the sweet cherry. It is serious largely because of its varied hosts (given here as half a dozen—almond, apple, cherry, peach, pear, plum, quince—and perhaps including another fungus, *M. fructigena*, according to some authorities) but more particularly because of the very considerable injury that it causes to the fruits for which these plants are grown. However, because it attacks these chiefly only when they ripen, it cannot be considered as a very aggressive parasite. Wet weather at the time of ripening the fruit is largely the controlling factor in its development and injury. It is one of those imperfect fungi that bear their spores exposed on the infected parts. In this case they are thin, oval bodies produced in chains on short, grouped threads together forming powdery, gray *pustules* evident on the fruit but less conspicuous on the blossoms and young twigs. These spores are also produced on the infected twigs and mummied fruit adhering to the trees in the spring thus causing new infections. On the fallen peach mummies half buried in the soil are developed small, black sclerotia. On these latter there is rarely found here in the spring the asco stage, known as *Sclerotinia fructicola*, showing as evident, cup-shaped bodies on elongated pedicels. These cups produce spores which when shot into the air are carried by the wind to the young parts of the tree and cause early infections.

Because of the abundance of spores, their easy infection of the ripening fruit and their general rot-production with repeated new sets of spores, the control of this fungus, especially in wet weather, is difficult. Spraying must be repeated several times on the young fruit up to its ripening period. It must be harmless to the host, stick fairly well and especially coat the fruit, which is difficult on cherries and plums. This coating often proves an objection if it is fairly evident when the fruit is sold. In the past spraying, according to different hosts, with Bordeaux, Atomic Sulphur, Self-boiled L. & S. and dusting with fine sulphur, especially on the hairy fruit of the peach that favors sticking, have given more or less success.

Corn

Bacterial (Stewart's) Wilt, *Aplanobacter Stewarti.* This trouble was first described by Stewart of the New York Geneva Station (Bull. **130**:423-430) in 1897, hence the common name used to designate it but he gave no scientific name. This

was supplied in the scientific description by Smith the next year in his publication (Proc. Amer. Assc. Adv. Sci. **47**: 422-426) though he called it a Pseudomonas at that time. We have had complaints in the past of obscure corn troubles in this state but we were unable to link them up with this one either by specimens or descriptions sent in without specimens. Nevertheless Rand and Cash of the U. S. Dept. of Agr. (Jour. Agr. Res. **21**: 263) in 1921, listed Connecticut as one of the seventeen states where it had been found.

In 1919 there was complaint of a trouble of sweet corn and in our examination of Golden Bantam at Woodmont and Milford, after the stalks had attained large size, we noticed a fairly large amount of root rot that we laid at that time to a Fusarium. We are now convinced that it was chiefly due to Stewart's wilt since we also noticed the presence in the injured tissues of a considerable amount of bacteria as well as the Fusarium. An earlier examination, no doubt, would have shown bacteria as the primary cause. The Plant Breeders of our Station also report the presence of this trouble in their variety tests in 1931 in a minor way. So the trouble is not entirely new to the state and presumably has caused more or less serious injury in certain past years. This leads us to hope that it will again fade out under less favorable conditions for its development.

Early in June in 1932, however, there was called to the attention of the writer a trouble of early sweet corn that definitely proved to be this disease, showing first by the lower leaves wilting and then drying up, usually a greenish color somewhat like that caused by a late frost or drought. The earliest planted corn at this time was about two feet high, while the latest planted fields were about six inches high. The trouble appeared first and most prominently in the former, though the latter fields in time showed the injury less prominently. Examination of the wilted plants whose roots and stalks seemed to be normal when pulled from the ground showed, when cut lengthwise, that there was a badly injured, reddish-brown spot at the very base of the stem from which the first roots develop. When the stem was cut crosswise at this diseased spot, and examined with a lens, one could see a yellowish, or occasionally at first a whitish, sticky ooze proceeding from the cut ends of the bundles scattered through the stem. These exudations contained countless numbers of microscopic bacteria that clogged the bundles thus cutting off the water supply to the leaves with their resulting wilt and death, especially with the advent of the hot, dry weather that came later in June and July. Other plants made a poor growth with no maturity of ears. In some cases the rot invaded the whole base of the plants and even the roots, so that the stalks were finally easily pulled from the ground. Where the invasion of bacteria was late or slight, the corn suffered correspondingly little.

It is claimed by some that this disease is carried only by the seed and so they have advocated purchasing seed from the north where the disease in the past has seemed to be less prevalent. During the past two years, several states have reported the disease on the increase. In 1932, however, the disease was unusually serious in various regions. We had the greatest outbreak that had been seen in Connecticut up until then and we heard of even more severe losses in Pennsylvania, certain midwestern states and Ontario, Canada. So the trouble was rather bad and widespread. We had much less injury to the late planted sweet corn and practically no complaint of the normally late planted field corn. While Golden Bantam and some of its crosses suffered most, we found injury almost as bad on early planted other varieties. The varieties seen were Atkin (local), Early Yellow Sensation, Golden Bantam, Golden Early Market, Golden Gem, Golden Sunshine, Long Island Beauty, Spanish Gold, Surprise and Whipple's Yellow. The varieties came from various sources and it seems to the writer that the season, as well as the variety and the source of the seed, had something to do with the presence and severity of the attack so far as Connecticut was concerned.

In 1933, the trouble was even worse here than in 1932, and it seemed to be generally worse over the country where sweet corn is commonly cultivated. We tried various forms of prevention by seed treatment, but these were not entirely satisfactory. There was, however, considerable difference in the different varieties grown on the same land and planted at the same time. At present we can merely suggest the following measures as more or less satisfactory:

The Seed. Use the best seed possible and, if known, from fields that had the least trouble. Plant varieties the least susceptible to the disease, especially of the golden varieties, and preferably use the white ones. So far the early or medium early varieties that have shown the least injury from this disease here have been Golden Cross Bantam, Whipple's Yellow and Spanish Gold. Treat the seed with corrosive sublimate tablets for further protection, using at the rate of 1-1000 for 20 minutes. Some growers plant the seed abundantly in the rows and hoe out the suspicious plants as soon as seen, hoping to get a good stand of healthy plants finally.

The Land. Plant in land not in corn recently; we have seen fields, however, where the trouble ran as high as 30% that had not been in corn for several years. Preferably plant on land where manure has not been used in the past few years, especially hog or cattle manure where corn stalks have been fed to the animals.

The Fertilizers. Use only a complete chemical fertilizer. We saw one field which ran only 5% of injury where a complete chemical fertilizer was used, while the same seed from the same source ran as high as 30 to 50% on the same farm in fields fertilized with hog manure.

Practice if possible all of the above precautions.

Dill

Black spot, *Phoma Anethi.* The only fungus we have found on dill, *Anethum graveolens,* was seen at a vegetable farm at Wethersfield in September, 1926. On a dying but still green plant we found on the leaves, but especially on the stems, somewhat numerous, small, oval to linear, black pustules running between the parallel veins and when abundant merging into long striae. These pustules were papillate with merged fruiting bodies but they were so immature that we could not definitely identify them. While a few, small, Phoma-like spores were seen, the receptacles mostly looked like immature perithecia.

The only fungi reported on this host in America are a Phoma and a Cercosporella (later described by Saccardo as Cercosporina). Our specimen does not agree with the latter, as it has no external Cercosporella spores though otherwise it could be it. We have one specimen of the so-called Phoma from Iowa and it agrees fairly well with the general description given by European writers. Fuckel, who listed this fungus under Sphaeropsis, mentioned finding larger stylospores (apparently the Cercosporella spores) later in the development of the fungus.

We have examined stained sections of the infected stems of three American specimens (ours from Connecticut; one from Iowa, U. S. D. Agr. Herb., labeled Phoma; and Brenckle's Cercosporella, Fungi Dak. 353, from North Dakota) and three exsiccati specimens labeled Phoma from Europe, and we have come to the conclusion that they are all merely different stages of the same fungus. They show one or more of three different stages as follows.

First, the Cercosporella stage develops just beneath the epidermis and comes from a localized, colored, sclerotial mass of cells. When the colored, scarcely septate cells of the conidiophores begin to elongate from the upper end of this sclerotial mass they break through the epidermis and develop their elongated, lighter-colored spores at and near their nodose tips. The Dakota specimens seem to show this stage alone and so give a grayish, fuzzy appearance to the outbreaks different from most of the other specimens.

Secondly, we find a pycnial stage with small bacteria-like spores or spermatia which gives rise evidently to the generic name of Phoma usually applied to the specimens. Lastly we find in similar enclosures an immature stage of colorless cells that seem to be the beginning of an asco stage. One or both of these two stages are shown in the other five specimens examined. Both the pycnial and the immature asco stages are enclosed with similarly colored cells like those found in the sclerotial stage. The Iowa specimen and one or two of the European specimens, to a less extent, show all three of these stages thus indicating their relationship.

When the mature Ascomycete is found then we can really know what to call the fungus which so far has been known chiefly as *Phoma Anethi* and under which name we place it provisionally here. The fungus is interesting chiefly because of its obscure life history rather than because of any harm it causes as a possible parasite.

Elm

Dutch elm disease, *Graphium Ulmi.* This disease was first noticed in the Netherlands in 1919, and has since spread to a number of other countries in Europe, being especially serious in Holland, Belgium and certain parts of France and Germany. Apparently little effort has been made in Europe to prevent the spread by cutting down the infected trees. It occurs there on a number of different species of the elm but is worse on some than on others. Some effort is being made in Holland to secure resistant trees by selection, since certain seedlings of the same species are said to be more resistant than others. Apparently *Ulmus pumila* is one of the most resistant of the species. *Graphium Ulmi* is the immature stage of an Ascomycete that recently has been found in its mature stage, known as *Ceratostomella Ulmi.*

This disease was first reported in this country from Ohio during the summer of 1930 and has been found there on about a dozen trees though only one was reported in 1933. In the fall of 1932 it was also found in New Jersey and in 1933 in New York State. By the end of February, 1934, more than 1000 trees had been found in the general vicinity of New York city, most of them, however, in New Jersey. One tree was also found in Baltimore, Maryland.

There are said to be two types of injury, one which kills the trees very quickly and the other more slowly. The infected trees show a wilting or yellowing of the leaves, sometimes limited to certain branches, and often a premature dropping of the foliage as the first evident sign of the trouble. Sections of the twigs an inch or less in diameter may disclose a dark-brown streaking in the wood, usually as small spots in cross sections, extending in the rings of those of one to four years old. However, the evidence may be limited to the death of the cambium layer in certain serious cases. It is necessary to obtain artificial cultures from the injured tissues for exact determination since other fungi may cause them. Certain species of European beetles spread the disease to healthy trees by carrying the spores to the young twigs. These beetles and the imported diseased logs are said to have been the source of infection in the United States. A quarantine has been put on the importation of infected logs. So far the only remedial measure practiced here is the destruction of the infected trees.

During the past six years the botanical department of this Station has been on the lookout for this trouble in Connecticut but more especially in 1933 when it was found in the nearby states of New York and New Jersey. By the end of 1933 only one infected tree had been found in our state—that discovered by Mr. Dunbar at Glenville in Fairfield County not far from where the disease was earlier found on trees in Rye and White Plains in New York State. Cultures of Graphium were obtained from this tree both by the U. S. Department of Agriculture and our Station.

A second infected tree was found by the Government, and confirmed by its and the Station's laboratories, in Greenwich in February, 1934. This tree apparently became infected as early as the spring of 1931, as shown by spots in the wood of certain of its main branches. Some of the larger limbs were already dead when found and on these lower down near the still living tissues, between the inner bark and the outer wood, were the channels produced by the European bark beetle, *Scolytus multistriatus.* In the youngest of these main channels the dead female beetles that produced them were often present and in the side channels, running out from each side and filled with frass, could be seen some of the living larvae ready for this year's further development.

In some of these main channels were also found numerous, fully developed fruiting bodies of the Dutch Elm fungus. These bodies, called coremia, visible to the naked eye but much more evident with a hand-lens, are clusters of dark-colored threads bound together into definite, erect, bundles bearing at their tips a viscid mass of minute, hyaline spores. In the side channels nearly sessile and less mature fruiting bodies were seen under the frass, and also, in one case, on and under a dead larva. When the bark was placed in a damp chamber for a day or two a white bloom appeared all over the bark adjacent to the channels. Under a lens it was shown

to be chiefly the very young coremia producing countless numbers of the spores at their tips.

It is evident that when the living larvae emerge as beetles and fly to the healthy trees, which they injure somewhat by chewing the bark at the base of young twigs, that they may carry with them some of these spores which, gaining entrance through the injured places, can become the source of further injury.

Both of the infected trees in Connecticut have been cut down and burned. **In the vicinity of the tree at Glenville no other suspicious trees were found.** In the neighborhood of the Greenwich tree, several miles from that at Glenville, however, several suspicious, smaller trees have been seen and from the spots in the wood of the small branches cultures are now being made for positive identification. These trees, too, will be cut down if found infected.

The botanical department also has made a number of cultures from suspicious branches from other trees but all these have turned out to be caused by other fungi. These have been species of *Cephalosporium*, *Verticillium*, *Sphaeropsis* and *Fusarium* which usually do not cause serious trouble. However, the elms in certain parts of the state have also suffered from insects, drought and winter injury and it is certain that these injuries as well as the Dutch Elm disease have had something to do with the death or decline of the elm. It will take at least another season of scouting to determine how widespread this latter trouble has become.

The writer is not in favor of creating a popular scare concerning this trouble, with large state expenditures, which might result from a concerted attempt to cut down all suspicious elms in New England. Rather he is in favor of the destruction of infected elms only when the trouble appears in a new locality and then in a limited way. He believes that the better campaign is the spraying of the elms against insect troubles, the fertilization of languishing trees, together with the destruction of badly injured trees in an effort to limit the spread of the carrying insects and the fungus, rather than an attempt to exterminate the disease.

Gladiolus

Dry (Sclerotial) rot, *Penicillium Gladioli.* We have seen this storage trouble only occasionally on corms of gladiolus. It was first shown us by Mr. Hopson, Superintendent of the Station Farm at Mt. Carmel, in the spring of 1933 but others reported similar trouble soon afterward. The infected corms reveal a somewhat sunken, reddish-brown, dry rot of varying size and depth. The skin at first covers these areas but shows on its surface, especially after being kept in a moist chamber, a growth of whitish, yellowish or greenish fungi, chiefly Penicillium. When the injured spots are cut across one is surprised to see the tissues more or less crowded with small, flesh-colored sclerotia about .5 mm. in diameter. They are more evident on the exposed, broken diseased tissues. They resemble somewhat those of *Sclerotium Delphinii* but are more of a flesh than a reddish-brown color and are smaller. Mites also may be evident in the diseased tissues, especially if these have been kept moist for a short time. The appearance of the trouble agrees so closely with the description and figures given by McCulloch and Thom (Jour. Agr. Res. **36**:217-24, F. 1928) that we attribute it to the new fungus described by them.

We suspect that injury by the mites or mechanical injuries when the corms were stored, perhaps not thoroughly dried out, aided the trouble. How it affects the plants grown from these corms the writers of the article do not say. They state, as we would expect, that treatment of the corms with fungicides showed these sclerotia as rather resistant.

Some of the diseased corms, both treated and untreated, were planted by us in the spring of 1933 and the trouble was confined to the injury in the corms since the leaves that developed from them showed no special disease but merely a weakening from the badly injured corms. Badly diseased corms, especially when the injury is near the eyes, will not develop strong plants even if the fungus does not attack the leaves produced. They therefore should not be planted.

Lawn Grasses

Toadstools and Shelf fungi. On lawns a great variety of toadstools appear at different seasons of the year but especially in the spring and fall. Some of these produce fairy rings. Where certain chemical fertilizers are used sometimes the mycelium of molds appear. Where manure is used unusual toadstools, especially of the deliquescent type, also appear. None of these fungi usually cause any harm to the grass and most of them are not poisonous. Some people have been afraid lest their small children eat them when left on the lawns but we have never heard of any trouble of this sort.

The meadow mushrooms, Agaricus species, with the pink and then dark-colored gills and a ring around the stem, are often eaten. The Coprinus species, with deliquescent gills that go down to an inky liquid, are also edible. Very often *Coprinus micaceus* can be found in the spring in large clusters in the parking grass on the streets or on lawns where trees have been cut down and can be told by the minute glistening scales on the caps as well as the deliquescent, black gills. All such fungi should be gathered in their younger stages for food.

However, when the lawn is on the edge of woods some of the poisonous Amanitas are likely to be found in the fall. It is these that are often eaten by foreigners from southern Europe. They are made deathly ill or frequently are killed by them. Usually they gather them from the edge of woods rather than from lawns. The two common species are the deadly agaric, *Amanita phalloides,* and the fly agaric, *A. muscaria.* Both of these have *white gills, a ring on the stem and a volva (a swollen or cup-like enlargement) at their base.* The deadly agaric has caps varying from white to brownish in different varieties and the fly agaric has white, fluffy scales on a more or less evident, orange cap. Avoid any toadstools of these general types.

Where roots or stumps are buried in the soil we have even found fleshy forms of **woody fungi appearing on lawns.** One householder recently brought in fruiting bodies of *Polyporus frondosus* over eighteen inches in diameter that showed up in his lawn, apparently from buried roots of trees. We have seen the same fungus around the privet hedge fences in other lawns. This fungus has a white, poroid, fruiting, lower surface and a somewhat darker, smooth, upper surface. It is at first fleshy but with age becomes somewhat corky and the overlapping segments are free at their circumference but united to a common central or one-sided base.

Lilac

Bacterial blight, *Bacterium Syringae?* During the past few years the writer has occasionally found, early in the spring, young shoots and leaves of lilac that looked as if they had been killed by a late frost. Sometimes isolated, reddish-brown spots occurred on the more mature leaves, showing in strong contrast to the normally green, healthy tissues. While we could occasionally find bacteria in these dead areas, we were inclined to believe that they were the results of late frosts, since they did not seem to spread afterward. In late May, 1932, however, we were called to a nursery in Simsbury where this trouble was so conspicuous that it looked as if great damage would be caused if it was a bacterial disease and continued to spread further. Here, as before, the injury was confined to the new shoots killing them and the young leaves but spreading more extensively and conspicuously than we had seen it before, even to the spotting of the mature leaves. Also, we could find bacteria in isolated places in the leaves and stems which often became blackish in color.

The question then arose: Was the trouble due to frost or bacteria? In this case the lilacs were large and had been transplanted the year before, apparently in the fall, and were cut back some to induce new growth. This was what was chiefly injured, especially the suckers at the base. The grower did not think that frost was responsible and while the land was somewhat low we were not sure that other plants in the nursery had been injured by frost. The injury was largely confined to the common lilac rather than to hybrids or other species, not recently transplanted, that were in the same nursery. On the other hand the injury agreed with Elliott's description of *B. Syringae* which has been reported on a great variety of

woody plants under different names. We tried to infect young lilac leaves and stems with crushed extracts from infected leaves and stems but without very evident results. On the other hand we were equally unsuccessful in trying to produce similar injury by subjecting the young stems and leaves to freezing temperatures in a refrigerator for definite periods. In August we again visited the nursery but the trouble had failed to progress further.

If this trouble was due to the bacteria, it seems to us that it is primarily one that develops on young tender tissues and fails to progress further on the mature tissues, much like the bacterial rots of stone fruits, and that it was favored by the recent transplanting of the old bushes, since where we have seen it elsewhere it has not seemed to progress later that year or become more prominent the next year. In this particular nursery, also, the trouble was quite inconspicuous the next spring.

Of course where not too evident the trimming off of the infected branches helps to improve the plants and lessen danger of spreading the next year if the disease is primarily due to bacteria. In this nursery we gave certain of the shrubs a very good coating with potassium-oleate Bordeaux, some evidence of which remained on them until the first of August, but as the trouble had not progressed we do not know that it had any particular value.

Lily

Gray molds, *Botrytis* sps. In 1932 we had complaints from several sources of the spotting or wilting and premature death of Madonna and Regal (*Lilium regale*) lilies. On the definite, light spots, often with a purplish border on the leaves of some of the plants, no fruiting stage was evident but when these leaves or the wilted plants were placed in a moist chamber there appeared a white mycelial growth from which Dr. McCormick isolated cultures that uniformly proved to be a Botrytis. This species made a luxuriant, white growth on the media with usually a few, large, black sclerotia. The conidial stage when seen was of the Eu-botrytis or Sporotrichum type with small, globose spores rather than the Polyactis type with larger, spherical to oval spores as with *B. cinerea*. However, in the early summer of 1933 we had sent us a Madonna lily that showed similar spots on the dying leaves but on the rotting blossoms there was an abundance of the large-spored Polyactus type, possibly *B. elliptica*. It looks as if there may be two species of Botrytis that work on the lilies here; in Europe several have been listed.

An herbarium specimen of Madonna lily collected in New Haven in 1908, shows very definite, conspicuous, elliptical spots. The contents of these spots have so completely disappeared that when they are placed in water and examined under the microscope the branched threads of the mycelium are very evident in the tissues as seen by the transmitted light. That the fungus does fruit under certain conditions in the infected tissues was shown by a more careful examination of the specimens collected in 1932 and kept under moist conditions for a time. A microscopic surface examination of boiled pieces of the leaves showed, in some places, tufted conidiophores issuing from the stomates and bearing clustered groups of spores at their upper ends.

Control measures are doubtful but one, at least in securing new bulbs or plants, should select only the best and plant in a new location. Keep water off the leaves and blossoms. When the bulbs are left in the ground, the old leaves and stems as soon as dead, as well as any suspicious bulbs, should be removed. In the spring when the plants appear spray them and the bulbs with Bordeaux.

Oak

Drought injury. In 1930 and 1931, following the drought years of 1929 and 1930, there were several complaints after midsummer of oak trees dying in the woods of certain sections of the state. Even 1931, while it had more frequent rains generally over the state, should be considered a dry year in certain sections so far as the roots of forest trees were concerned, since the temporary streams, springs and wells still showed a lack of water. An examination of the trunks of these injured trees, chiefly oaks, showed that they sometimes began to die at the bottom but more frequently from the top downward. Some of them were already dead or past help. Sometimes the leaves dropped off or withered on the branches and then the limbs died but usually with no positive evidence then or afterward of suspicious fungous growths or insect injuries. While occasionally we did find fungi on the injured or dead bark (as Nectria, etc.), and again on the dead or dying twigs (as Sphaeropsis) we were unable commonly to associate any of these as the direct cause of injury but rather as weak parasites or saprophytes following it. Usually the trees that suffered the most were in low, rocky soil but in one case they were on a high, rocky hill.

Our explanation is that the trees gradually died from lack of water, the injury first killing the root hairs and then the other parts of the tree, usually those above the ground first. The succeeding winter, as always, made the trouble prominent the following spring and summer. The trees that suffered first and most severely were those that were accustomed to abundant water as in the low, moist lands or the high rocky hills near temporary water holes and small streams. Trees that were more accustomed to dry conditions were able to pull through in better shape. The trees that showed the injury chiefly were *Quercus primus* and *Q. rubra*.

The only treatment was to cut down the trees and make use of them before any heartwood rot or insect injury started. We expect that forest and shade trees may continue to show obscure injuries from this drought period.

Another trouble, seen occasionally in 1931 on individual trees in yards on *Q. alba*, etc., was where the small twigs with their leaves dropped off in midsummer. Sometimes the green leaves, apparently pinched at the base of the petioles, were shed separately. No signs of insect or fungus injury was seen either on the leaves or twigs and we were inclined to lay the trouble to drought entirely. The injury, however, had some resemblance to the Verticillium trouble of trees, though Dr. McCormick found nothing suspicious in the twigs she examined.

Onion

Gray mold, *Botrytis Allii*. A great variety of common and scientific names have been applied to this disease of onion bulbs. Personally, as the trouble is common in the onion districts of the country and is only a semi-parasite and agrees fairly well with the common gray mold mentioned here under a variety of hosts, we doubt if it is really distinct from *Botrytis cinerea*. It becomes conspicuous after the onions are stored, showing the gray mold more or less abundantly on the bulbs especially at the neck end. This imperfect fungus, with the blackish conidiophores bearing the bunches of gray spores at their upper ends, is also accompanied by the evident, black, flattish, sclerotial bodies embedded in the outer tissues that carry the fungus over in unfavorable periods. Sometimes these sclerotial masses are more abundant and conspicuous than this same conidial stage which they may reproduce under favorable conditions for germination. So far the asco stage has not been reported.

A conidial stage of apparently this same fungus may also appear on the living leaves and especially on the blossoms of seed onions where in wet years it may cause more or less damage especially to the latter. However, it is chiefly to the bulbs in storage that the greatest damage occurs. This is apparently due to infection before the bulbs go into storage and is favored there by poor storage conditions. These latter include unfavorable conditions of ventilation and heat which are often increased by placing the onions too deeply in the containers or not allowing enough air space between the racks or crates used. One of the chief causes, however, is pulling the onions and leaving them in piles on the ground so the green leaves will dry out. In wet or cloudy weather this may occur so slowly that the fungus gets a good start in the bulbs before they go into storage.

We have seen cases, years ago, where a large part of the harvested crop was finally lost and have heard of others where the shipment of onions by boat, said to be in good condition when sent, had been received by the dealer in New York in a worthless condition. The white onion, especially the Southport white variety, suffered here by far the most and this is one of the reasons onion growing in that part of the state has largely disappeared. At present onion growing all over the state has so greatly declined that complaints are now rarely received concerning this trouble.

Some years ago we tried spraying the white onions once or twice with Bordeaux mixture shortly before they were pulled and again after they were loosely piled on the ground, turning them over to get the spray on all sides. These onions when dried out were then placed under more favorable storage conditions with the result that these precautions somewhat lessened the rot. The experiment was for one or two seasons only but we believe this is one of the proper ways to go about the trouble. If spraying is tried potassium-oleate should be used as a sticker on the living plants on account of the glaucous conditions of the leaves. Other writers have advocated cutting the top close to the bulbs at harvest time and artificially drying the bulbs at 90 to 120° F. for two or three days and then storing them at 32° F. with as low humidity as possible.

Smut, *Urocystis Cepulae.* Years ago this was a prominent trouble in seedling onions grown in this state. Where onions were grown in the same soil for some years the smut finally became so bad that large acreages had to be abandoned or at least limited to sets which were not infected. During the past thirty years, however, the writer has only occasionally met with this trouble. Even after a smutted soil had not been in onions for five years it was said to be unsafe to plant onion seed in it. We knew of one case where the field had become so smutted that it was given up for this purpose and then ten years later was tried again when a moderate number of seedlings became smutted and the second year this was, of course, considerably increased.

The smut shows on the seedlings soon after they appear above ground as evident pustules, at first covered by the epidermis of the leaves, that soon rupture disclosing the black, dusty spore mass. Often these leaves are twisted and the first ones are soon killed. If abundant many of the young plants also die so that those that come to maturity are greatly reduced in number and the resulting crop correspondingly limited in amount. Where infection is less or later in developing, the onions may develop to maturity but show the black, smutty masses on their external layers and the bulbs are more or less reduced in size. As stated before the spores may retain their virulence in the soil for a long time. (Fig. 43.)

Thaxter (Repts. **1889**:129; **1890**:103.) of this Station was apparently the first botanist to give a careful account of this smut both as regards its life history and its preventive treatment, though Farlow had previously considered it from the former point of view. Thaxter tried a number of chemicals in the infected soil at the time of planting as preventive measures, and at harvest time he narrowed these down to two of the most successful ones—sulphur (with lime) and sulphide of sodium. He advocated the former because of its cheapness and availability. Sturgis later carried on experiments with sets on infected soil and advocated this as a method of relief. *See* Rept. **1895**: 176.

Some years ago the writer made a few experiments for controlling onion smut, based on experiments at Ohio and New York, with formalin as a more modern method as well as lime and sulphur. We did not have so great an amount of smut in the land treated and so apparently did not get as evident results from the formalin treatment as some others have reported but this was the more successful method. It seemed also to be better than the lime and sulphur. We had trouble with the latter in wet soil forming a crust when dry and interfering with the young seedlings in pushing through it.

The method now commonly advocated is to have an onion planter with an attached reservoir for holding a supply of formalin that allows, by a special drip attachment, wetting soil and seed before the latter is covered by the shovels. The formalin is a 1 to 2% dilution (1 pt. formalin to 6 to 12 gals. of water) and the amount required varies with the strength of the solution and the wetness of the land. This will probably take one to two hundred gallons per acre for the treatment.

Peach

Yellows. Yellows is one of our old troubles of the peach caused by that mysterious agent which we commonly call a "virus" and the nature of which on any plant has not yet been entirely explained. It is apparently related to the yellows of raspberries and of asters, less so to the mosaic of tobacco and other hosts, in

many of which insects are the common carriers of the virus from the infected to the healthy plants. As yet a carrier* of this sort on the peach has not been determined, though lice or leaf-hoppers seem to be the most plausible.

The symptoms of yellows as seen on the fruit, are its premature ripening a few days to more than a week before that on the normal branch or tree, also often a higher color, especially with reddish spots on the skin or in the interior tissues, particularly near the stone, and the peaches affected have an insipid or poor flavor. The foliage at first becomes prematurely yellowed and is apt to be somewhat curled at the edges and finally scanty and smaller. Water sprouts may appear on the stems with similar, sickly foliage that in the final stages show as small, witch's-broom effects. The larger branches with their foliage gradually die followed finally by the death of the whole tree.

The writer has long been interested in this subject and has conducted various experiments to determine the cause of the same both in private orchards and at one time in a Station's "Yellows" orchard. As first demonstrated by Smith of the U. S. Department of Agriculture, it is easy to infect seedlings or even bearing trees by setting buds from yellows trees into the healthy trees. We were even successful by merely using a small, oblong strip of infected bark with no bud on it. In either of these cases in time the whole tree becomes infected. We were not successful in securing infection from infected leaves and stems when placed in the ground around the roots or from liquid material placed in holes in the stems and then plugged up. We did not, however, use special means to force the liquid into the sap circulation of the tree. Neither did we succeed by using pruning shears on healthy trees after constantly moistening them with tissue from infected trees. Likewise we were also unsuccessful in inoculating a tree or its fruit by using pollen from yellows trees to fertilize the blossoms of a healthy one, though in most cases the fertilization was not completed.

The few attempts by us with the species of lice common to both raspberries and peaches that developed on mosaic plants of the former and were placed on trees of the latter in closed outdoor cases, were without positive results. It is quite possible, however, that eventually an insect carrier may be found. In our orchard investigations we have never surely traced spreading from naturally or artificially infected trees to the healthy adjacent ones. Neither have we seen a case of spreading by dragging infected trees through the orchard or replacing a diseased tree by a healthy, though some have claimed such results. Spreading by this process might be expected if insects are carriers of the virus.

We came too late into the state to observe the results of the legalized tree destruction in the orchards where yellows was thought to exist. Fundamentally we are opposed to such measures or to quarantines unless evidence is first shown that they are necessary or likely to prove financially profitable to the grower and not too burdensome to the state. Apparently in this case the growers as well as the state did not desire to continue the legalized destruction of infected and suspicious trees. To our mind the comparative infrequence of the trouble here during recent years seems to result chiefly from the greater care the nurserymen use in selecting peach pits and buds from sources where there is less danger of producing the disease in their nursery stock offered for sale. Whether winter injury and the type of fertilization, as using potassium nitrate, have had their influence we cannot say. One needs to be very careful to distinguish yellows from winter, drought or peach borer injuries

Pear

Fire blight, ***Bacillus amylovorus.*** Pears are rarely grown in this state in large orchards so their troubles are perhaps less common and conspicuous than elsewhere. With the fire blight, often called pear blight, we have a trouble that has proven troublesome especially on certain varieties and in some years, though it rarely seems as bad here as in certain other regions. As is indicated by the common name, it is a bacterial disease and is largely spread in the spring by bees and certain other insects. The bees mechanically carry the germs from

*Since this was written Kunkel has proved that a leaf-hopper, *Macropsis trimaculata* can transmit this disease from yellows peaches to the healthy.

blossom to blossom and some of them are left behind in the nectar. Developing there they soon work down into the young tissues killing the blossoms or later the immature fruit and even the tender twigs with the blackened attached leaves. This seems to be our chief type of trouble. Once the disease gets started on the main branches or trunk, however, large cankers may finally result with serious injury or death of the tree. The infected tissues, under certain conditions, ooze out drops of liquid containing multitudes of the germs and these through insects and other means are distributed and thus spread the disease.

The trouble here on pears is most conspicuous on Bartlett especially where cultivation and fertilization has stimulated quick new growth. Quince bushes also seem to be as commonly injured as the pear. Apples, except sometimes in the nurseries, are not usually so seriously injured as in New York or Pennsylvania, perhaps due to the varieties grown or to the more moist spring weather in those states. With us the chief injury to apples in the orchard is shown by the killing back of the young twigs, after blossoming, in the favorable seasons for the development of blight. The English Hawthorn is apparently another susceptible host though the blight is not very common on it here. The only other hosts reported here have been rarely Mountain Ash and once years ago, by Sturgis, plum.

Little can be done to prevent infection by insects unless it be by spraying to help kill the particular insects that carry the germs, though protection by spraying at blossoming time in orchards may lessen the set of the fruit. **Large cankers** are taken care of by cutting off the badly infected limbs some distance below the canker. Other less serious cankers can be cut out, using tools kept clean by wiping them with a cloth wet with a disinfecting solution, described below, using especial care that the tools are absolutely clean when cutting in the healthy bark or wood. With shallow bark cankers, the infected bark may be removed merely by scarifying it but with a deep seated canker one may need to go into the wood.

In cutting the bark and in trimming infected but unimportant branches, the poisonous solution (1 part mercuric chloride, 1 part mercuric cyanide, 300 parts glycerine and 100 parts water, all by weights) should be used in cleaning the tools. On the cut out cankers, a coating of Bordeaux paste is also recommended by some. All diseased bark, twigs and wood removed should be burned. This treatment can probably be best done in winter when there is less danger of spreading the disease. Where the trouble is confined merely to killing the young twigs early in the summer after blossom infection, it is doubtful if one need to go to the trouble of trying any remedy.

Periwinkle (Myrtle)

Black wilt, *Undetermined fungus.* Early in the spring of 1932 we received injured specimens of *Vinca minor* sent from Long Island and later in the season came complaint from Stamford in this state where the trouble had been noticed for two or three years. At first we thought it was due to winter injury since there was no evidence of a fruiting fungus on the leaves and in many of them no mycelium. In August after examining specimens from several places at Stamford and later in a Bristol nursery, we came to the conclusion that it was an obscure fungous trouble. Some of the leaves and the younger stems died prematurely. They turned a blackish color in contrast to their normal green. Where the leaves were killed by a girdling of the stem they evidently were not invaded by the fungus and merely turned a light-brown color. The leaves on the stems in some cases died from the base upward while the other leaves showed no sign of infection at that time.

The only fungus we could find at first was a Phoma-like one with very small pycnial spores on some of the old dead stems. After leaving the injured leaves and stems in a bell-jar for some time, however, a fruiting stage of a Phyllosticta (*P. minor*) with larger, hyaline, ovoid to sub-globose spores, 7–10μ by 6–7.5μ in size was seen on some of the leaves and this also was found in October on the old dead leaves at Bristol. At the latter place we also found on some of the leaves dark-colored spores of *Sphaeropsis Vincae* in somewhat similar but larger pycnia. Both of these fungi are under suspicion but further work needs

to be done to determine whether either of them was the cause of the trouble.

We believe that several sprayings with potassium-oleate Bordeaux, beginning in the spring, should be helpful in controlling this trouble. It might, likewise, be advisable to remove all the dead refuse in the fall and cut off any new infected growth that appears the next season even if the plants are sprayed.

Persimmon

Scab, *Fusicladium Levieri.* While a few apparently native specimens of *Diospyros virginiana* are in existence at Lighthouse Point, we have never collected any disease on them. However, this species and the Japanese persimmon, *D. Kaki*, are also occasionally cultivated on estates and in nurseries. On the Japanese persimmon and on some of its crosses with the native species, we have received from Dr. Morris of Stamford, in two different years, specimens of a leaf disease that we have placed under the genus Fusicladium. This fungus is similar to the apple scab since it shows as an evident superficial mycelium, just below the cuticle of the epidermis, radiating out from a central point. The spots on the leaves as seen by us were from 2 mm. to 10 mm. in diameter, chiefly circular in shape and of a dark or purplish color. The mycelium was largely confined to the upper surface of the leaves and the exposed spores were lanceolate, rarely slightly curved, one-septate, chiefly 20 by 4–5μ in size and about the length of the clustered sporophores.

Two species of Fusicladium on Diospyros have been reported from Japan, *F. Kaki* and *F. Diospyrae*, but we have seen no specimens of these and Saccardo has given no description of them, so we cannot say whether they are distinct or whether our specimens agree with them. Another species was described by Magnus in 1900 on *D. Lotus* from the Caucasus and named *F. Levieri* and our specimens seem to agree fairly well with his description though we have no specimen from that region. On the other hand Berkeley and Curtis named a specimen, *Dendrina Diospyri*, collected by Ravenel from Aiken, South Carolina, on *D. virginiana*, but apparently gave no description of the same. This was issued by Ravenel in his exsiccati Amer. Fungi no. *588* and later sent by him to three other individuals who also issued it in exsiccati (de Thuemen, Myc. Uni. no. *1282*; Roumeguère, Fungi Gall. no. *4595*, Ellis, N. A. Fungi no. *854*). The radiating mycelium on the upper surface of these specimens resembles that of ours but it is longer and the spots are much larger and there were no spores that we could find. Saccardo does not recognize this genus and apparently gave no description of this particular species. With the data at hand we, therefore, place our fungus, provisionally, as given above, with the assumption that it is also a new species to the United States.

Dr. Morris thought that this fungus might have been responsible for the leaves being partly shed early in 1932 but this does not seem probable because of the apparently slight injury caused. If necessary the fungus should be controlled by spraying as for apple scab.

Phlox

Leaf spots, *Cercospora omphakodes, Septoria divaricata, S. Drummondii.* We have found the first fungus not uncommon on the leaves, apparently rarely also on the stems, of species of phlox of the type of *Phlox paniculata* or its crosses, often when they were not doing very well. Yet in most cases the fungus was not so abundant as to account for much of the injury, so we have laid most of it to obscure insect or drought injury in such cases. The spots are of moderate size, somewhat subcircular, usually with a whitish center and a purplish border. However, the color of the central part may vary with its age or condition since in herbarium specimens it often shows darker. While these spots may be common on the plants, we have often failed to find the fruiting stage but when present it shows the conidiophores and septate, slender spores as a more or less evident growth chiefly on the under side of the leaves. This imperfect fungus apparently has not been connected up with any Ascomycete and also needs further attention concerning its life history.

The second fungus, *Septoria divaricata*, also seen here on *Phlox paniculata* and probably also on *P. divaricata*, produces somewhat similar but often more irregular, whitish spots in which its imperfect stage shows as small, black dots embedded in the tissues. It was originally reported in this country by botanists, including the writer, as *Septoria Phlogis* of Europe, but Ellis and Everhart, who also reported it as that, later described it as a new species having smaller and less evident septate spores. Its asco stage apparently has not been discovered though that of *S. Phlogis* is said to be *Leptosphaeria Phlogis*.

Ellis, who with Everhart named both of the Septoria given here, evidently thought that the one on *P. Drummondii*, called *S. Drummondii*, was distinct from *S. divaricata* by its somewhat larger spores which according to him are still smaller than the true European *S. Phlogis*. We have not studied these three species carefully enough to decide whether or not they are really distinct though we do list the two species here on these two hosts and there seem to be some differences in the size of their spores and of the spots they make on their hosts.

The treatment of these three fungi would be the same. Even if the mature stages have not been found on the old dead leaves, the infected plants and their rubbish should be destroyed in late fall after their death. We also suggest spraying with Bordeaux, starting on the young plants in the spring and repeating if necessary up to about blooming time.

Potato

Blight, late, *Phytophthora infestans*. Not only is this the most serious but it is the most noted of all the potato troubles, since it once caused a famine in Ireland. In the past many individuals and even governments have carried on investigations to determine its cause and control. Fortunately in many places it occurs lightly or not at all in the normally dry seasons though in wet regions, especially in the north, it may become very destructive. It is now definitely known that the trouble is due to a downy mildew belonging to the Phycomycetes though at one time there was great dispute as to the cause. In this state it has never appeared in the fields before the first of July and then only in seasons very favorable for its development. If the season is dry or wet weather comes late in the summer, it may not show until late in August or even not at all. The fungus usually gets a fair start in the fields before it is commonly noticed and then, with cloudy damp weather or continued rains, it seems suddenly to spring into prominence throughout the field.

The imperfect or conidial stage is developed chiefly in the leaves and its mycelium spreads through the tissues causing a blackish rot, when wet, but shriveled and brown when dry; it may invade the whole tip of the young stems or just a leaflet or part of it according to the weather conditions. The mycelium in wet weather quickly forms its external conidial spores by developing fruiting threads through the stomates in the epidermis of the leaves. These can usually be seen as a whitish or frost-like growth on the under sides especially at the juncture of the diseased and healthy tissues. The mature stage, like similar fungi, should develop conspicuous, round, resting spores within the infected tissues but these have never been found in America and apparently it is doubtful if they have been elsewhere. However, that such a stage may exist was proven by the writer in his early cultures of this fungus in artificial media years ago. (Fig. 48.)

The manner by which the fungus carries over the winter and infects succeeding crops is through the perennial mycelium in the tubers which reproduces the conidial stage when the seed pieces are planted in the field. According to the writer's opinion these conidia are washed from the tubers into the soil, germinate to form the usual motile bodies (or similar ones are produced from a still undiscovered oogonial stage) which eventually infect the leaves when they come in contact with the wet ground. Rarely one finds plants in which the fungus has grown up the sides of the young shoots and fruited there but this does not seem to be the usual method of field infection. From the primary infected plants the conidia produced on them are blown or carried to other plants and gradually infect the whole field. There seems to be a certain age before the plants become generally infected since we have seen older, badly infected plants adjacent to

younger plants that failed to become badly infected until they reached about the same stage of development. The chief injury to the potato is not only the premature death of the vines, before they have produced a full crop of tubers, but often also the loss of the tubers after their production through rot. The fungus in this case is merely instrumental in opening the way through killing the outer tissues and thereby admitting the soft rot bacterial organism for their general decay. *See* page 300.

There seem to be no very desirable varieties that are resistant to this disease. The first step in control of the disease is to secure seed tubers free from the disease. The disease on the tubers is shown as a dry, reddish-brown rot, often somewhat sunken or pitted. All such tubers should be rejected in the seed cutting. However, merely selecting absolutely free seed will not suffice, since if the season is favorable the disease can be carried into the field from diseased plants even from some distance. Spraying, therefore, is the commonly accepted treatment for blight years, especially with late potatoes. With early potatoes in this state, since the blight does not cause serious injury more often than once in three or four years on the average and since these potatoes are commonly dead before it appears, it is not the general practice to spray for this trouble.

With the late potatoes the spraying with Bordeaux mixture should begin the last of June to control, with an insecticide, the potato bugs and to cover the lower parts of the plants that will not be so easily reached later on. The sprayings should be thorough and applied often enough to give a good, continuous coating on all parts of the vines. This can be done with a 4–4–50 mixture or better and less frequently with an 8–8–50. Hand spraying can be done most efficiently in small fields or gardens but the use of a power sprayer is now considered necessary in the larger ones. Dusting with Bordeaux is advocated by some but so far we have not had as good results with this or any other dust or spray as with the home-made Bordeaux spray

Raspberry

Leaf curl. This is one of the virus types of disease that have recently been investigated on raspberries, showing chiefly on the red varieties. It has been proven by different investigators to be caused by a virus that can be carried by certain aphids from the diseased to the healthy plants. We found it abundant in our Experiment Station patch of Cuthberts during the last three years. The trouble is somewhat similar in nature to the mosaic disease on the same plants and the two were at one time confused under the general term of yellows. The leaf curl can be told by the more stunted, stiffer plants, being most evident on the leaves. The leaves especially are stiff, and curl downward and inward from the tip and margins, and thus cause more or less puckering at the veins. There is also a tendency for the leaves, petioles and upper internodes to be shortened. The leaves often are of a deeper green color though along the veins they may have lighter streaks but there is no distinct yellow-green mottling as in the normal mosaic.

Our somewhat isolated experimental field, in cooperation with the U. S. Department of Agriculture, was started in 1926 with inspected plants said to be free from mosaic. Unfortunately one lot, which was received in the best shape and made by far the best growth when planted, before the end of the first year began to show some mosaic. Twice each year leaf curl and mosaic plants in the patch have been removed to see if this was a practical method of control. No leaf curl was seen the first year and it has only been during the last three years that it has been prominent, gaining each year until in 1931 two hundred twenty-one leaf-curl plants as compared with two hundred fifty-three mosaic plants were removed. Whether this is an indication that leaf curl is merely a more advanced stage of mosaic, somewhat as curly dwarf is to potato mosaic, we are not prepared to say. We can state, however, that from its insignificant beginning in this case the leaf curl became a more serious trouble than the mosaic. The experiment was ended at the conclusion of the 1932 season. *See* further statement under Mosaic.

Mosaic. Like the leaf curl, mosaic is most serious on the red varieties and is especially common here on the Cuthberts. It, too, is a virus disease carried

by aphids from the diseased to the healthy plants. Its chief characteristic is the yellow-green areas in the normal green leaves, thus giving them a mottled or mosaic effect. Sometimes this mottling is more evident than at other times and when faint one needs to shade the vines from the strong sunshine to see it best. It is usually more evident on the younger leaves than on the old ones. At times the old leaves are normal while those above are mottled, thus indicating their recent infection. In time the virus spreads through the plant and even the young sprouts from the underground runners may eventually develop the trouble. This makes it difficult to eradicate the disease since these rootstocks are rarely entirely removed in pulling up the infected plants. One needs also to distinguish it from yellowing of the leaves, especially the older ones on the old canes, that is due to drought or insufficient fertilization.

In our experimental field already mentioned, we had in general an increasing number of mosaic plants each year up to 1928, but after then a usually decreasing number, despite our efforts to lessen the trouble by removing the diseased canes and sprouts twice each year. The following data indicate the number of diseased (both mosaic and leaf curl) plants, including both mature canes and sprouts, removed each year:—in 1926 there were removed 180; in 1927, 290; in 1928, 1211; in 1929, 644; in 1930, 720; in 1931, 474; in 1932, 241 (removed only once in 1931 and 1932). As stated under leaf curl one of the four lots from different sources began shortly after planting to show some mosaic plants. The other three lots, planted a week or two later in dry weather did not do so well and many of the plants died from these adverse conditions so they did not fill out the rows especially at the higher end of the land. At the end of the first year at least one hundred and seventy-two mosaic plants were pulled out of the poorly inspected lot while in the other three well inspected lots only eight plants were removed. The wet year of 1927 was very favorable for aphids so that the next year infection showed up very prominently. At the end of 1931, while there were about the same number of plants that survived the first year (about two thousand plants), there had been pulled out during the six years practically thirty-five hundred plants and sprouts. The practice had been, however, to encourage new sprouts free from the disease to come in where the old diseased canes and sprouts had been removed. At the end of the experiment in 1932, there were 1411 healthy plants, 147 dead ones and of the diseased ones only 89 showed mosaic as compared with 152 with leaf curl.

On the whole this experiment does not indicate a practical solution for control of mosaic and leaf curl by removing the infected plants. However, it does indicate to the writer that the grower should strive to obtain inspected plants as free as possible from these troubles and that they should be planted in an isolated field. The grower should then watch carefully for the first signs of these troubles and destroy infected plants as soon as they appear. This should be kept up until the number removed gains considerably when it can be discontinued and the patch be allowed to remain as long as it is profitable financially. When it becomes unprofitable, the owner should start again with other inspected plants in another isolated field.

Rose

Crown gall, ***Bacterium tumefaciens.*** This bacterial disease on most of its hosts shows as evident, swollen growths usually at the bottom of the stems or on the roots below the soil. These swellings are generally semiglobose and vary from about one half an inch to three inches in diameter. There may be only one gall at a place or several may be close together. At first they are fairly soft and usually on herbaceous plants they remain somewhat soft but on woody plants they become hard through the infection of the woody tissues. Cross sections of the galls shows a mixed arrangement of the different tissues as contrasted with the normal regular arrangement. In the different hosts on which crown gall has appeared in this state most have been on woody plants. In one case we found it on the tap root of the mangel and in another forming curious distortions on the base of aborted or stunted stems of greenhouse sweetpeas. Artificially, however, we or Dr. McCormick have produced it on seedling Norway maple and several herbaceous plants, such as Bryophyllum, geranium, string bean,

tobacco and tomato. The following is the list upon which the crown gall has been found naturally in the state, mostly in the nurseries: apple, bittersweet, blackberry, chrysanthemum, Euonymus, grape, honeysuckle, mangel, mockorange, mountain ash, peach, pear, plum, poplar, privet, raspberry, rose, sweetpea, willow and Wisteria. (Fig. 50.)

It is a question just how much harm this trouble causes to the infected plants. Nursery inspectors usually throw out any infected plants, chiefly because of the damage the crown gall has caused in the south. Here in Connecticut, we have seen no orchards that have suffered from this trouble. We have on two occasions examined apple trees that had crown gall when they were set out but, so far as we could tell on later examination, they had suffered little injury. It is possible that this trouble becomes more injurious in blackberry and raspberry plantations but we have had no complaints. On herbaceous plants and the less woody plants like the grape, the galls die prematurely and gradually disintegrate and so show at least local injury. The most prominent of all the infections that we have seen have been on certain varieties of roses (Rosa sps.) in greenhouses. In most cases we believe some injury occurs to the vigor of the stems and the general production of blossoms. In this host the galls break out any place on the stems but often occur at the cut ends. Some believe that the growth at these cut places is due to embedded crown gall strands that reappear at the new callus growth, and others that these surfaces are reinoculated by the germs on the shears used in cutting the stems.

We recently tried an experiment to test these two theories. On one bench we dipped the shears, each time before cutting, in a receptacle containing a saturated solution of corrosive sublimate and then wiped them off with a towel. On the next bench we let the men trim the roses after the normal fashion. This was done with both benches at the end of the blooming season. From the experimental bench we removed 570 galls from 306 plants and, as at least 40 more were removed a short time before, the plants averaged two galls to each plant and one had even eight removed. These varied from a very small size up to two inches in diameter. The check bench had 408 plants but we did not count the galls the men removed from there but presume it had fully as many per plant. Six months after removing the galls from the benches we counted 65 galls (or 21 to each 100 plants) on the experimental bench and 164 galls (or 40 to each 100 plants) on the check bench or about twice as many per hundred plants. Eleven months after removal there were counted 170 galls (or 56 to each 100 plants) on the plants on the experimental bench as compared with 280 galls (or 69 to each 100 plants) on the check bench. On the whole these unusual precautionary measures did not yield extra good results on these badly infected plants.

Leaf blotch, ***Actinonema Rosae.*** This is a serious trouble with certain varieties, especially of greenhouse roses. It shows as purplish, circular, evident spots on the leaves usually a quarter to half an inch in diameter when mature. If abundant the leaves turn yellow and drop off prematurely. The radiating mycelial threads give rise to rather inconspicuous fruiting pustules on the upper surface of the leaves. On the old dead leaves an Ascomycete, *Diplocarpon Rosae,* is said to mature in the spring but we have never collected this stage. In the greenhouses some growers report this as the chief obstacle for successful production of certain varieties. One grower reported Premier Supreme as the variety he had the most trouble with while Templar was next and Briar Cliff was the least injured.

We recently tried spraying Johanna Hill in a greenhouse during the off season just after the plants were started again for new growth. We used Bordeaux on some plants and on others potassium sulphide, both with a sticker of potassium oleate. On these plants twelve sprayings were made between June 10th and September 10th. When the blossoms began to be picked abundantly about this latter date the spraying was discontinued. During this time the watering was kept down and the disease did not spread much even on the checks. With the start of blooming the subsequent frequent watering, or dusting as it is called, not only started the vigorous blooming but also the spread of the blotch. The frequent watering of the susceptible varieties, while it may be necessary as the grower believes for successful production of blossoms, is the chief cause of the

spread and serious injury by the blotch. This was shown by growing this and other susceptible varieties in the Station's drier greenhouse where the blotch failed to bother though the bloom was not as great.

We believe that in between these extremes of watering the careful grower will find the best results in the end. It might also pay to spray once in two weeks in the off season, as we did, provided that the whole house is treated, since in our case we used only a few of the bays in a large house. For roses out of doors, we recommend, as in the greenhouse, the removal and burning of the old leaves, in this case in the late fall, and then in the spring and early summer several sprayings with Bordeaux before blooming time.

Rutabaga

Bacterial black rot, *Bacterium campestre.* This is the host, *Brassica campestris,* upon which Pammel first described the disease in 1895 although it is now known on a number of cruciferous plants. We have found it in this state on cabbage, cauliflower, kale and rutabaga. On each of these we have seen it several times, though rarely causing serious injury. The most serious case was in 1929 on cauliflower, where the grower had planted about fifty acres and did not get a fifth of a crop, chiefly due to this trouble. As in other years the trouble was due to an unusually wet season, in this case late in the summer. The trouble often starts as a wedge-shaped yellowing and then a wilt at the edge of the leaves but the chief characteristic is the blackened bundles that carry the water and food and along which the invasion of the bacteria proceeds. The infections usually start at the edge of the leaf in the little drops of water that adhere there in damp and dark days and the bacteria work through these into the intercellular spaces and bundles within discoloring the latter. In time a soft rot may occur in the thickened tissues, as in the heads of cabbage and cauliflower and in the roots of the turnip. This is due to the invasion through the injured tissues of the soft rot organism which follows this more parasitic species.

As the trouble occurs so infrequently, it is difficult to control. One should be afraid of it in wet years but after its appearance it is too late to do much good. We have an idea that insects are instrumental in carrying the germs, especially thrips in the special case we mentioned. Care in selecting purchased plants or of their growth in seed beds should be exercised. The grower should practice rotation with the related crops on which the disease may occur and never use land for them on which the disease appeared the year before. If doubtful about the seed, this should be treated since the germs can be carried in this way. We treated cauliflower seed two years for a grower who experienced this trouble the year previous to our first treatment. He had no trouble the two years the seed was treated but he rotated his crop chiefly to new land and these two years were dry rather than wet ones. We soaked the seed in these cases for fifteen minutes, using corrosive sublimate 1 to 1000 on half the seed and for the other half in formalin 1 to 250. The seed was dried immediately after treatment. There was no ill effect on the germination of the seed in either case as compared with the untreated seed.

Mosaic. We had recent complaint from a Meriden farmer of a trouble to his rutabagas that became worse in succeeding seasons, since he saved certain of his roots for seed plants. Dr. Dunlap, who investigated this trouble, found lice abundant on the plants in the field but also a more or less definite mosaic mottling of the leaves. By greenhouse experiments he was able to prove that it was a true mosaic trouble, rather than merely lice injury, by transferring the disease through injections with infected juice from the diseased plants to both healthy tobacco and rutabaga leaves. *See* Tobacco.

Spinach

Damping-off, ***Pythium debaryanum, Rhizoctonia Solani.*** We have placed these two fungi here for general discussion since they are the fungi that are usually responsible for damping-off of a great variety of plants in cold frames, hot beds, greenhouses and gardens. They act in much the same way, rotting the seedling near its base, causing it to fall over, wither and soon dry up and disappear. If a lot of seedlings are killed in one place, their destruction is more evident especially when they are grouped together. These fungi also cause injury to mature plants, especially in the case of the Rhizoctonia.

For seedlings grown outdoors for general farm crops, we have tried dusting and soaking the seed, treating the soil in various ways and spraying the young seedlings and we are not yet satisfied to recommend any general preventive treatment along these lines. The best we can do so far is to state that the seed should be good and not planted too early or deeply in the soil and then leave it to the grower and the Lord that the rain is just right for rapid germination of the seedlings and not especially favorable for the development of either of these damping-off fungi. We treat each fungus separately and then give the method of limited sterilization of soil in seed beds and greenhouses for their prevention:—

Pythium, on the whole, we have seen more frequently on its hosts in hot beds and gardens than in the greenhouses, this being especially true of spinach. This phycomycetous fungus is usually found in its white, non-septate, mycelial stage running on and in the tissues near or under the ground, usually rather inconspicuously. Later it develops in these diseased tissues its round, single, oospores (usually less than 25μ in diameter) with a free oogonial wall, in greater or less abundance to perpetuate the fungus. Very similar to these oogonia are thinner walled, temporary sporangia producing zoospores that spread the disease temporarily but which we have seen much less frequently. As a damping-off fungus, we have listed it here on the following seedling plants: beets, cabbage, cucumber, lettuce, muskmelon, pansy, pepper, pines, spinach, stringbean, sweetpea, tobacco, tomato; and as a rot of the roots and other parts of the more mature plants, on celery, pea, sweetpeas and tobacco.

Rhizoctonia, as with Pythium, likes dampness for its vigorous development but it often causes more harm when developing in an acid soil, where we have found it causing abnormal injury to unusual plants. It develops a larger and more vigorous mycelium that creeps over the exposed tissues so that it is often evident to the naked eye. At first this mycelium is colorless, at which time it seems to cause most of the damage, but in time it becomes more or less deeply colored reddish-brown. Often the threads are bunched together into strands which seem to aid in pulling the invaded plants together as in grasses. Another characteristic is the position of the septum that separates the side branch from the main branch, this being situated just above the base of the side branch. In the damping-off plants no spore stage is found. Not only does this fungus cause a damping-off of seedlings but it also frequently causes a rot of the mature parts of the plants; for a list of these and a further statement concerning its life-history, *see* Potato. We have found it causing damping-off on the following seedlings: barberry, beets, cabbage, egg-plant, Boston ivy, lawn grass, lettuce, pepper, pines, radish, spinach, sweetpea, tobacco, tomato, white pine, yew. No doubt there are many other seedlings to add to this list.

Treatment to prevent damping-off, as given here, is for a limited area of soil, as in seed beds, flats in greenhouses, etc. In the first place, one should be careful in watering; use just enough water to germinate the seed and aid hardening of the seedlings, for after a certain age there is little danger of trouble from these fungi. For that reason many growers plant their seed in soil not very rich in humus, using a sandy soil and even a coating of pure sand on top in some cases. After certain plants have passed the damping-off stage, they can be transplanted to a richer soil to stimulate further growth before they are set out permanently. If one has trouble even with this method he can try sterilization of the soil. However, even with this treatment, he needs to be careful of his watering of the seedlings. We have tried a great variety of methods of sterilizing the soil and spraying the emerging seedlings, chiefly with beets and spinach, and we find the best method to date to be as follows: Use at the rate of one pint, or 16 ounces, of glacial acetic acid in 10 gallons of water, or one pint, or pound, of formalin in 6¼ gallons of water and gradually sprinkle either of these liquids over the soil at the rate of two quarts to each square foot; cover with boards or cloth to keep in the fumes for a day and then expose to allow their escape; do not plant the seed for 14 days after treatment.

Downy mildew, *Peronospora Spinaciae.* For a number of years we looked for this fungus on spinach without success and then accidentally ran across it in 1915. Since then we have seen it many times, especially from 1923 to 1926 when it became epidemic in fields around Westport and Stratford and to a less extent at Wethersfield, Hartford and New Haven. It forms definite, yellow spots on the leaves on the under side of which in time appears the conidial stage as a grayish to purplish-tinted growth. The conidiophores produce the evident woolly growth while the spores formed on their ends give the violet or purplish tint. We have not seen the oospores that should appear in the embedded tissues but possibly these may develop in the old dead leaves.

While we give the downy mildew here under the specific name (*P. Spinaciae*) derived from its host's genus (Spinacia) and to which it is said to be limited by some authorities, we are doubtful if it is really distinct from the species *P. effusa,* found here commonly on the related weed known as Lamb's Quarters, which readily produces both the conidial and oogonial stages. We tried in 1925 and 1926 to infect these two hosts with the conidia from their own and the other host but were not successful with them when the conidia came from the opposite host. However, we are not certain that this never occurs and we need further work to see if this also holds true with the germinating oospores before we can decide whether or not they are really distinct.

While a good deal of damage was claimed from the fungus at the time of its epidemic, we found that in reality the glut in the market with imported spinach, thus cutting down the price, was partly responsible for the failure of the growers to market some of their own product, thus at the same time increasing the amount of damage the mildew caused.

We tried during these years various experiments to determine which was the best way to avoid damage from this disease. We grew many varieties from a number of sources to see if any were exempt from the trouble, and while we found considerable variation in the amount of mildew that appeared on them this seemed to be due to accidental infection rather than to any varietal resistance to the disease. We also treated the seed and soil and tried various dusting and spraying experiments on the young plants but none of these were effective enough to recommend them as a method to be put in practice. In one experiment mulch paper was used just after the seedlings appeared above the ground to prevent their leaves from coming in contact with the soil in their later growth. This was done with the idea that primary infection might come from germinating oospores in the ground and that this would be a good way for its prevention. This, too, was not entirely satisfactory.

As a result of all of our experiments, the only suggestions that we can make are: 1st, yearly rotation; 2nd, continued early destruction of the Lamb's Quarters, on the possibility that the oospores produced in the infected plants carry the fungus over the winter and may be a source of spinach infection the next spring.

Tobacco

Fertilizer injuries. These may be due to two general causes; namely, when the fertilizer comes in direct contact with the tissues and burns them; secondly, when there is a certain element needed by the plant the absence or scarcity of which causes a more obscure trouble. In the first case we frequently in our survey found injury in the seed beds due to the careless use of fertilizers on the young plants. This came from scattering the fertilizer on the leaves, especially when moist, and then failing to wash it off thoroughly at once into the soil. As a result a burn of the foliage, a white spot or a more general irregular injury, appeared. There was a term, yellow-chit, applied by certain growers to an obscure trouble which showed as a decided yellowing of the very young leaves and bud but which was usually later outgrown. We could never really decide if this was due to slight injury by the fertilizer sown over the plants or to cold bordering on freezing. In the fields, where fertilizers were used too strong or too close to the roots of young plants, injury sometimes resulted that was difficult to distinguish from the brown root rot described previously.

The other type of injury, due to the scarcity of a certain element that is essential to the normal growth of the plants, was seen chiefly in field tobacco.

For instance, lack of nitrogen shows in a less vigorous growth and yellowed foliage of the leaves. During the war when potash was difficult to obtain, tobacco growers complained of poor tobacco, especially where no manure was used and fertilizers with very little potash in them or none at all. The tobacco was less vigorous, the leaves yellowed at the tips, and between the veins spotted and puckered. More recently the soils department of this Station has shown this deficiency of potash in experimental plants by their smaller size with lower, thicker, puckered, white-spotted leaves with downward curved tips. The trouble gradually progresses upward to the later leaves as they mature. Deficiency due to lack of magnesium, known as *sand drown* but more common further south than in this state, is shown by similar poorer growth with white or yellow areas between the veins of the leaves but without the puckering and curling. In this case the trouble is apt to occur here when only certain artificial fertilizers, without magnesium, are used, and the deficiency of the magnesium is shown by the stealing of this element from the lower leaves to supply it to the growing leaves above resulting in the spotting. In time the leaves above may show similar spotting.

Mosaic (Calico). This trouble on tobacco was first called to attention in this country by Sturgis in 1898. He did not determine its method of spreading and did not believe it was contagious or caused by fungi, insects, nematodes or apparently by bacteria. He favored the belief that it was a physiological trouble due to certain weather and soil conditions. The writer in 1906 first began experiments to prove that its spread was due to handling diseased and then healthy tobacco as indicated by certain experiments of European investigators. It is now known that the juice of mosaic tobacco plants contains a virus so that the disease can be communicated to healthy tobacco by handling, or by lice through punctures. What this "virus" is no one as yet knows; evidence is accumulating, however, that it is of a proteid nature.

The general appearance of the trouble is the same as with mosaic of other plants already described, namely, a distinct yellow-green mottling distributed in mosaic fashion in the normal green of the leaves. When it is bad the plants are reduced correspondingly in size and weight. The mosaic plants make poor wrappers on account of brittleness and other undesirable qualities and so the price received for crops is less when this trouble is evident. The top of growing plants showing this trouble is called "mottled top" and this condition is due to late infections. The trouble sometimes shows a little in the flowers also. The new sprouts from harvested tobacco are often mosaic because of increased infections through harvesting. The trouble is not carried by the seed. The disease is not visible in the leaves matured before infection although the virus may be present in them later. (Fig. 59.)

At first a good many different plants, when found to have mosaic, were considered to be caused by the virus of tobacco mosaic. More recently the tendency seems to be to consider these as distinct troubles. We showed in 1908 that the mosaic on tomato could be caused by the virus from tobacco. We have also produced mosaic on various solonaceous plants from mosaic tobacco juice and have had indications that it will produce mosaic in the Cucurbitaceae, though infection of these hosts is not easily produced by handling or artificial injections of the virus from either tobacco or members of the Gourd family. The mosaics reported here which are similar to or identical with that of tobacco are on the following plants: bean (Lima and string), blackberry, clover, cucumber, dahlia, eggplant, fuchsia, horseradish, lettuce, muskmelon, pepper, petunia, potato, raspberry, rose, rutabaga, soybean, squash, sweetpea, tomato, zinnia.

For control, the tobacco seed beds should be watched and if mosaic is found common on any, plants from other beds only should be selected. If necessary the beds should be changed to soil not in tobacco before. If a few plants show the trouble destroy them and the surrounding ones and wash the hands before handling other plants. Never pull or set plants with juice on hands from mosaic plants. Never use old tobacco stems or tobacco refuse on seed beds or spit tobacco juice on them, and clean out the remaining plants after the setting is over. In suckering and topping, clean the hands and tools occasionally so as not to spread the trouble to healthy growing plants. In suckering and topping plants, leave the mosaic ones to the last and then take care of them alone.

Tomato

Blight, late, *Phytophthora infestans.* Late blight on tomatoes was first found in the state by Thaxter in 1890. He reported it here as well as in Maine, as causing damage to both the fruit and leaves, at least in Maine late in the season. Sturgis also in 1893 mentions this trouble as "frequently attacking tomatoes also", though his statement may have been based on Thaxter's report. Since 1902 the writer has especially looked for it on this host but failed to find it until recently. The first specimens that came to hand were sent by Extension Agent Wilkinson from a farm in Ellington in September, 1928, and on the first of October, 1931, we found a considerable amount at Wethersfield.

In 1932 this disease was again found and this time about the middle of September and from that time on it became quite evident in the general region of New Haven and Bridgeport, where we were able to find it in over twenty fields that we visited. A peculiarity of the disease is that it seems to become prominent in the late fall, apparently later than on the potato from which we might expect it to spread. It appears unlikely, however, that the fungus does spread from the potato to the tomato since, while it was general this year on the tomato, we had scarcely any reports of blight on the potatoes in the same localities.

In 1933, when a careful watch was made for its very first appearance, the primary infections were found on September first and by the middle of the month the disease was widespread and finally became more serious than we had seen it before. The trouble started this year with primary infections of leaves *in contact with the moist earth* and the spores developed on these spread the fungus to the upper leaves and finally to the fruit. We were able after the first outbreaks to obtain infections of healthy plants (kept indoors) by placing their leaves in contact with the wet infected earth in crocks for a few days. These observations suggest to us that primary infections come from the ground through the fungus in some way being carried over the winter in it.

The fungus appears in its conidial stage on both the leaves and fruit but in the latter case the spores usually develop only when the skin is cracked or the fruit is kept covered or in a damp place. We have, however, occasionally found the conidiophores and spores entirely within the tissues of the fruit. The fungus kills the foliage as it does on the potato but the chief damage so far has been to the fruit. Here it produces a conspicuous, reddish-brown, dry rot of the tissues chiefly of the green fruit. The infected tissues do not change to the normal red on ripening as do the adjacent healthy tissues. If the rot reaches some size, it may show concentric rings of growth occasionally. This rot extends more or less deeply into the interior and may finally become general, involving the whole fruit in a wet rot when other fungi and bacteria become associated with it. So far, as with the potato, we have been unable to find any mature or oogonial stage though we have looked carefully on the infected parts, especially on the fruit and seeds, at different times of the year and as late as the middle of November. Artificial cultures, too, have failed to develop anything except the mycelium and the conidial stage.

The mycelium is very evident in the tissues of the fruit and can be found mixed with the hairs on the outside of the seed. This indicates to us that it may be carried over *in* rather than *on* the seed. As yet, however, we have not been able after numerous trials to get the fungus to develop on the germinating seeds from infected tomatoes. The Marglobe, so far as we have seen, is the most seriously and commonly infected variety, possibly because of its being a late variety. At a certain seed farm we found crosses of this with other varieties that were also especially attacked. We have found it, however, on several other late varieties and on some causing very considerable injury to the fruit.

Early tomatoes seem, so far, to escape the trouble even when grown in the vicinity where the later ones become infected. Where desired, spraying with Bordeaux if done thoroughly, will control the fungus but in this case there may be slight trouble from the spray attached to the fruit if not washed off when it is sold. As the Marglobe seems to have been the guilty party for bringing in the trouble, we suggest avoidance of that variety for possible safety in lessening it.

Tulip

Botrytis blight (White spot) *Botrytis Tulipae (B. parasitica).* Hopkins, in his work on this disease at Cornell (Agr. Expt. Sta. Mem. 45) considers it apparently confined to tulips since, while he was able to infect species of Tulipa, he was unable to get satisfactory results with other plants except in a few cases where he injured their tissues before placing the spores or mycelium on them. In Connecticut we have noticed this trouble chiefly on Darwin tulips and it was reported in Bull. 222, p. 480, under the name of White Spot. At that time, we thought the trouble, first seen in May, 1919, was due to frost or smoke since no sign of a visible fungus on the injured petals of the Darwin flowers was found. Since then we have seen this same trouble at various times in the spring, especially when wet and cool, and with the light shed by Hopkins's article, we have been able to secure, through artificial cultures, a Botrytis from the infected tissues.

As seen by us the trouble shows principally on the dark-colored petals as small, slightly elongated specks or small spots that more or less fleck their surface. Similar ones also show to a less extent on the leaves. They are at first discolored or water-soaked but usually when dry show white with a more or less definite dark border. As remarked before, usually no growth shows on these spots. In time, however, a more general invasion of the tissues may result with evidence of the conidial stage appearing on the dead areas. On the dry, outer skin of the bulbs, it is said, small, black sclerotia, about 1–2 mm., often develop and beneath these on the more tender white coats often can be seen small lesions which may develop further under certain conditions. Apparently this Botrytis differs from the common *B. cinerea,* which has also been reported on the tulip, in its smaller sclerotia.

It is difficult to advise treatment for this disease since we have had no practical experience. Of course all the rubbish from the old plants, including the soil on which they fall, should be cleaned off the beds as soon as the plants die back. Then in the spring, as the plants come forth, it might be helpful to spray them and the ground with potassium-oleate Bordeaux before blossoming time. Plants in the spring that show weakened growth or produce poor flowers should, with their bulbs, be pulled up and destroyed.

White Pine

Blister rust, *Peridermium Strobi.* Since the wholesale destruction of the chestnut by the blight white pine, *Pinus Strobus,* has become our most valuable timber tree both in the forests and in the plantations. Consequently we have obtained data on all of the fungi that have been found on it in this state. Of the sixteen species so far determined, we have listed only half a dozen as apparently parasites. But besides these parasites we have also noticed an even greater number of injuries due to other causes.

Of all of these troubles, the Blister rust is the most injurious one although evidently not so serious here as in certain regions where the conditions favoring its spread are much more favorable. The scientific name given here is that applied only to the O-I stages that occur on the white pine. The II-III stages, occurring on various species of Ribes, are known as *Cronartium ribicola* which by some writers is also applied to the stages on the white pine. Our chief concern in this state, however, is the injury caused to the white pine rather than to the currants and gooseberries. These latter are species of Ribes of which we have listed nine, both cultivated and wild, as found infected here. The white is the only pine in nature that becomes infected in this state. With Dr. McCormick we have been able to infect a number of seedlings of other species, most of which are not normally grown here. These seedlings take the disease in varying degrees but in a few cases as readily as does the white pine. The most susceptible of these were two and three needle pines and included *Pinus canariensis, P. Pinea, P. Coulteri,* and *P. edulis.*

In general the rust develops a life history in about the following manner: Spores from the III or telial stage on the leaves of Ribes germinate *in situ* in the fall and develop a promycelium on which delicate spores, called sporidia, are

borne. These sporidia are blown onto the needles of the pine and, under favorable conditions of moisture and temperature, develop threads that push their way between the guard cells of the stomates into the interior of the needles. Once within the tissues they form a mycelium and become evident, usually the next spring, by a yellow spot on the leaves due to the bunching of the mycelium into a sclerotial mass. In time during this second year, the mycelium works down through the apparently healthy, green tissues by small strands into the base of the infected needles; then it begins to develop in the stems much more luxuriantly, causing a more or less evident swelling of the invaded bark. By the third year the fungus may cause dead, brown spots on the yellow, invaded bark from which ooze small, yellowish drops containing very small bodies known as pycnial spores. By the spring of the fourth year, the bark may show a more or less cracked or cankered area on which develop conspicuous, white blisters that on rupture disclose a dusty, yellowish mass of uredospores or the I stage. Once established on the pine, the rust may develop year after year these O and I stages until the canker surrounding the stem eventually kills the parts above. (Fig. 63.)

The function of the O stage is still not quite evident though recent discoveries of similar stages of other rusts have advanced our knowledge of its usefulness. The spores of the I stage, however, spread the rust to the various Ribes where on germination they infect the leaves through the stomates and give rise within to a limited mycelium that in a short time produces quite similar spores in very small pustules on the lower side of the leaves. These spores of the II stage may on germinating go on repeating the same stage on other Ribes leaves for several generations but eventually their mycelia give rise to the spores of the III stage. These spores are quite different and are united into compound, short, hair-like bodies developing generally on the under side of the leaves. Under moist conditions these spores germinate in position to produce a promycelium that becomes divided into four cells each of which forms at its tip a short process bearing the single sporidium mentioned at the beginning of this life history.

While this in general is the life history of the rust, it is known that sometimes the rust lives for several years on the pine before breaking out in the blister rust stage. On the other hand we have cut down the period to about one year from telia produced on the Ribes to the O stage on the pine seedling by artificial infection of pines kept over winter in the greenhouse. From the completed life history it has been determined that the rust is perennial on the white pine but is annual on the Ribes. Also the I stage on the pines does not infect, so far as yet known, the pines but the Ribes only; that the II stage is a repeating stage on the Ribes and that the III stage does not infect the Ribes but the pines only.

When efforts were first made in this state to control the rust, it was through the destruction of the infected pines, since it was by these that the rust was first brought here from Europe. This method was soon given up as impractical and attention was limited to the destruction of all wild and cultivated Ribes within 600 to 900 feet of the white pines since the sporidia produced on the Ribes are effective in spreading the rust to pines chiefly within that distance. Another matter of importance is the planting of white pines for seedlings in beds away from any danger of infection by Ribes, as infected seedlings are a very common method for dispersal of this rust. Where this care is impossible, the seedlings should be sprayed throughout the season of infection with Bordeaux mixture. Experience has shown that certain Ribes are more susceptible to the rust or at least are more frequent carriers than others. For this reason the cultivation of the black currant, *Ribes nigrum*, is prohibited by law in this state. *See* Currant, also Bull. 214:428–460.

Willow

Scab, *Fusicladium saliciperdum*. This has proved the worst trouble of the willow that we have ever seen in the state and it has been even more serious in some parts of New England and especially so in the Maritime Provinces of Canada where trees of *Salix alba* var. *vitellina* have been the chief street and shade species of certain regions. The trouble was first noticed by the writer

in 1927 (*See* Bull. 302, p. 443) but it had undoubtedly been present here and elsewhere in North America at least some years previously. We have since collected it in several of the New England states, in many places in Canada and once in England. The continued death of the young leaves and twigs on the infected trees during the few subsequent years so starved them that many died. When first seen by us in August, we thought that the trouble might have been due to late frosts, since the fruiting stage of a fungus was not seen on many of the dead leaves. Subsequent investigations, however, revealed the fungus listed here as the cause, and cultures and infection experiments proved that this was true. However, the anthracnose fungus, also described here, has at times been found as an additional cause.

The scab fungus in its conidial stage shows when fully developed a dense, greenish, swollen growth on the lower side of the leaves, particularly on the midrib and veins. It is somewhat similar to the closely related Cladosporium fungus which is also often evident but scattered on the dead leaves as a saprophyte. The scab fungus becomes especially serious by carrying over on the injured and dead twigs and thereby infecting the young leaves as they appear the next year. Many of these leaves it kills directly and on others, older when infected, it kills portions or produces spots. It seems to produce infection chiefly in the spring and, with moist weather at that time, may cause wholesale destruction of the developing leaves. Later in the season mature leaves, especially on healthy trees, seem to escape the infection to a great extent.

This fungus has been associated with an Ascomycete, *Venturia chlorospora*, found as a saprophyte on the old, dead, willow leaves by Aderhold and other European investigators. It seems from our investigations that the mature stage is a Venturia and recently Kochman in Poland is said to have obtained the scab stage from its ascospores developed on infected twigs cut off and wintered over under natural conditions. However, he did not obtain the asco stage from the scab stage in artificial cultures. The writer has made attempts to find this asco stage in America on the dead twigs and leaves at all times of the year but so far without success. He did find a certain Venturia on the dead leaves and Dr. McCormick succeeded from one of the collections in obtaining cultures from their ascospores which developed not a Fusicladium but a Cladosporium stage! However through the efforts of both of us we did succeed finally with cultures of the scab stage under certain treatments in producing, though rarely, true perithecia with mature asci and ascospores of a Venturia. The efforts to repeat these results under apparently similar conditions so far have been unsuccessful. The ascospores in these cultures were not the same as those connected with the saprophytic Cladosporium-Venturia and apparently not like those figured by Aderhold on Salix, but more like those figured by him and found by us on leaves of Populus.

Through the efforts of this Station treatments of the infected willows at Norfolk were carried on for three years. Considering the fact that the treated trees were badly infected and many of the large limbs were partly or entirely dead before any of the sprayings were given, the results were as satisfactory as could be expected. After the 1930 treatments, the spraying was discontinued and these trees went backward and were finally cut down, but check and other trees in the village proper had all been dead for several years. It appears from this that the spraying must be continued yearly until danger from infection on the sprayed or surrounding trees is entirely past. This is quite a bothersome and expensive matter that can be followed only when the trees are highly valued for either their artistic or historical importance, as in the case of the willow trees in the Evangeline Memorial Park in Nova Scotia.

The sprayings given by us consisted of four or five treatments with either Bordeaux mixture (4–4–50) or dry Lime-Sulphur (3–50). The first treatment should be on the dormant trees just before the buds break open, the second on the young unfolding buds, the third on them when one-half to two-thirds grown and the fourth on them when nearly or fully grown. The fifth spraying, if necessary, can be given later or an extra treatment crowded in earlier if wet weather makes it desirable. In this state the treatments would normally run from the last half of April to the first part of June.

FORMULAS FOR FUNGICIDES

SPRAYS

Bordeaux Mixtures

Ordinary Bordeaux

Lime 4 lbs. Copper sulphate 4 lbs. Water 50 gals.

This is the strength that has been used for the greatest length of time and on a great variety of plants. It is what is advocated for most vegetables (beans, cucurbits, potatoes, etc.) and grapes, strawberries, most shade trees and shrubs, and herbaceous plants where sediment is not especially objectionable. Formerly the lime used was fresh quick-lime that had been slaked before use, but now much of the Bordeaux is made from hydrated lime that seems to act just as efficiently and is easier to handle and keep. Only high quality spray lime should be used.

Weak Bordeaux

Lime 1 lb. Copper sulphate 1 lb. Water 50 gals.

This, or a 2–2–50 strength, can be used where it is desirable to have less sediment near blossoming and fruiting periods of certain plants, especially of those in yards and greenhouses. It is not so effective as a fungicide.

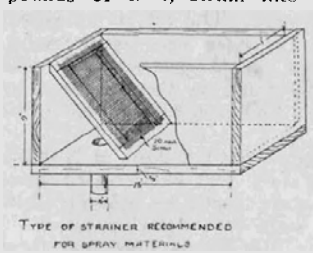
Strong Bordeaux

Lime 8 lbs. Copper sulphate 8 lbs. Water 50 gals

Some potato growers prefer this stronger mixture and it apparently covers the foliage for a longer period.

Making Bordeaux Mixture

Make stock solutions of copper sulphate and lime as follows: Dissolve 50 pounds of copper sulphate in 50 gallons of water, by suspending in a bran sack. One gallon of stock solution thus contains one pound of copper sulphate. Slake 50–60 pounds of lime, strain into a barrel and make up to 50 gallons. A gallon of this solution contains at least one pound of lime. The excess takes care of waste in slaking. Put two 50-gallon dilution barrels on a platform so that the sprayer can be backed under them. For a 100-gallon sprayer put 10 gallons of stock lime mixture into the lime barrel and 10 gallons of stock copper sulphate solution into the copper sulphate barrel. Dilute each to 50 gallons. By using a molasses spigot for each barrel, the two streams may be run together through a trough into the sprayer. A large, fine wire strainer should be set in the sprayer opening. The above amounts would make a 5–5–50 mixture. Lead arsenate or nicotine solution may be added if needed.



TYPE OF STRAINER RECOMMENDED FOR SPRAY MATERIALS

Some growers get good results with the following method: Start filling the sprayer with water, washing in at same time 10 gallons of the stock lime solution through the strainer. When half full, add the 10 gallons of stock copper sulphate solution with the remaining water, stirring meanwhile. When short handed, this method saves time. Half these amounts are used for a 50-gallon sprayer.

Quick Bordeaux

Copper sulphate can now be had so finely ground that the required amount can be put into the strainer of the spray tank and washed through with the water without previous dissolving. By washing through the strainer the required amount of hydrated lime, filling the tank half full, and then washing in the finely ground copper sulphate with the remainder of the water required, a very satisfactory Bordeaux mixture can be made directly for use.

Commercial Bordeaux

Commercial Bordeaux in a dust form can be purchased from dealers for spraying, with and without poisons. The former should not be used to spray parts of the plants to be eaten later. Commercial Bordeauxs are more costly than the homemade mixtures and often are not as effective. They should be used in the amount of water indicated by the manufacturer.

Lime-Sulphurs

Liquid lime-sulphur

Summer spray:

Lime-sulphur ¾ to 1½ gals. Water 50 gals.

This spray gradually supplanted Bordeaux on fruit trees because of russeting and leaf spotting by the latter. It is now being largely supplanted by the dry lime-sulphur for summer spraying because of greater ease in shipping and handling and less injury to the foliage.

Winter spray:

Lime-sulphur 5½ gals. (12 lbs. dry). Water 50 gals.

This is used on dormant trees to kill scales, etc., but is also useful in controlling leaf curls, especially on peach trees, and also lessens infection of apple scab where this is carried over on the twigs of susceptible varieties.

Dry lime-sulphur

Lime-sulphur 3 lbs. Water 50 gals.

There are now on the market several brands of dry lime-sulphur which, because of less danger of spray injury and convenience in shipping and handling, are replacing liquid lime-sulphur as a summer spray, though the latter, because of its lesser cost, is still largely used as a dormant or winter spray.

Dry mixture

Lime 4 lbs. Sulphur (fine) 8 lbs. Calcium caseinate ½ lb. Water 50 gals.

Mix thoroughly the lime, sulphur and calcium caseinate, and then add the water when needed. This fungicide is used in this state as a peach spray and to some extent as a summer spray for apple. It can be bought ready-mixed under several trade names.

Wettable sulphur, etc.

There are now on the market various forms of wettable sulphur, colloidal sulphurs, flotation sulphurs, much like atomic sulphur no longer on the market which had good sticking and fair spreading qualities on smooth surfaces. These newer fungicides are used as summer sprays to avoid injuries and it is hoped that eventually there will be found one that will have good fungicidal value, stick well to smooth surfaces and be generally applicable to a variety of hosts as has generally been the case with Bordeaux. Use according to directions given by the manufacturers.

Potassium sulphide

Potassium sulphide 3 oz. Water 10 gals.

This is used occasionally in greenhouses where spray is objectionable on flowers for the market. It was first used chiefly against powdery mildews as were the sulphur dusts and sulphur paint on the heating pipes.

Spray Spreaders and Stickers

Where the spray does not spread over smooth surfaces or stick well, various substances have been used with the fungicides to overcome these difficulties, such as fish oils, soaps, molasses and resin-Bordeaux. More recently certain forms of casein have been used. Commercial brands of calcium caseinate are on the market for this purpose. The value of this, because of increased cost and slightly increased spreading quality, is questioned by some, especially on peaches and apples.

On the other hand, with such plants as the leaves of cabbage and carnation, the stems of asparagus and raspberries and the fruit of cherries and plums, the ordinary sprays do not stick or spread enough to insure protection. Some special spray or spreader is needed for such plants. There is hope that some of the wettable sulphurs will solve the problem.

We have found potassium oleate the best spreader and sticker for Bordeaux that we have tried on both hairy and smooth plants. It is especially valuable around gardens and greenhouses, where its increased cost means little, if one does not object to the evident spray-coating on the plants and where one wishes it to last a long time with few applications.

Dusts

Bordeaux dust

This dust can be purchased from dealers under various trade names, with or without poison. Like other dusts it should be used early in the morning when dew is on the plants and when it is not too windy, to make it stick best.

Copper sulphate-lime

Copper sulphate dust (monohydrated) 25 lbs.
Lime (extra fine) 75 lbs.

This dust can be purchased but is cheaper when homemade. The two ingredients should be thoroughly mixed by some mechanical device. It is used chiefly as a dust on potatoes and celery by large growers. The water when present on the leaves changes it into a Bordeaux mixture.

Lime-sulphur

Sulphur 80–90 lbs. Lime dust 10–20 lbs.

If desired, add 10 lbs. of dry lead arsenate in place of part of the lime. The finer the sulphur the better are its sticking and fungicidal values. Lime-sulphur dusts can be purchased under different trade names.

Seed and Soil Fungicides

Steam and Hot Water

Seed. Steam and hot water have been used at various times for treating soils and the latter for seeds. Hot water treatment of seeds depends on the kind of seed to be treated as well as the temperature and time of treatment. It has been used at 125° to 135° F. for 10 to 15 minutes on certain grain seeds for smut. Other seeds, according to their protection, can stand higher or lower temperatures and for a longer or shorter length of time without injury.

Soil. Treatment of soils by hot water has not been very effective in most cases. For greenhouses and hot beds it is desirable to use steam from a boiler developing 75 to 125 lbs. pressure and inject this into the protected soil for 20 to 30 minutes. This will kill most of the fungi or their spores, nematodes and weed seeds, unless specially protected.

Chemical liquids

Seed. These treatments also vary with the seed and the time it is immersed. Seed should not be treated unless for some definite reason. We have used Formalin (one to 250 of water) on certain seeds like cauliflower and tobacco, soaking them for 10 to 15 minutes. We have also soaked the same seeds with corrosive sublimate one to 1000 for a similar time, both without injury to the seed.

For uncut potato tubers, we have used one pint of Formalin or four ounces of corrosive sublimate (the latter used in wooden containers) in 30 gallons of water for one hour. Gladiolus corms should be soaked in water containing corrosive sublimate, one to 1000 for three hours.

For organic mercury under various trade names, use as indicated by their manufacturers.

Soils. We have used two forms of fungicide on soils with more success than with any other chemicals. These have been Formalin (one pint, one lb., to 6¼ gallons of water, or two per cent.) and glacial acetic-acid (one pint, 16 oz., to 10 gallons water), either used at rate of two quarts per square foot of soil treated. This is then covered to keep in the fumes for a day or so after which the soil can be stirred to permit their escape, but plants should not be set for two weeks after the treatment.

Chemical dusts

Various forms of chemicals, such as organic mercury, copper carbonate, Formalin dust, etc., are used on seeds and occasionally on soils for treatment, chiefly against seed-carried spores (like smuts, etc.), slightly infected seeds, and damping-off fungi (normally in the soil). The seed is shaken with a small amount of these chemicals so that they adhere mechanically to the seed when planted. They aid in killing the spores or mycelium of the fungi, and thus prevent infection of the germinating seed.

Formalin dust, made by using 15 parts by weight of commercial formaldehyde with 85 parts of finely powdered charcoal or other absorbants has been used by Anderson with good results in the Station's tobacco seedbeds. He used 1½ ounces of the dust to each square foot of soil treated, working the dust into the soil about two inches. The seed was sowed immediately. Others had tried the same dust for prevention of damping-off of vegetable seedlings.

Recently some experimenters have claimed good results from the use of red copper oxide or zinc oxide dusted on the seed before planting, and others from the use also of copper carbonate or zinc oxide in water sprinkled around the seedlings after they came up, to prevent damping-off troubles.

INDEX TO FUNGI AND INJURIES

This index carries the scientific names, in *italics*, of the fungi, both parasites and saprophytes (also of the few parasitic nematodes, etc.), presented in the preceding pages, including those mentioned incidentally as mature stages, even when not found in the state, and the few synonyms given. It also includes the injuries mentioned, in ordinary type, under common names. All names are arranged alphabetically and the references are usually given under the common names of the hosts. This arrangement shows at a glance what specific troubles have been found here on various hosts. Scientific names of hosts and common names of fungi are not included in the index.