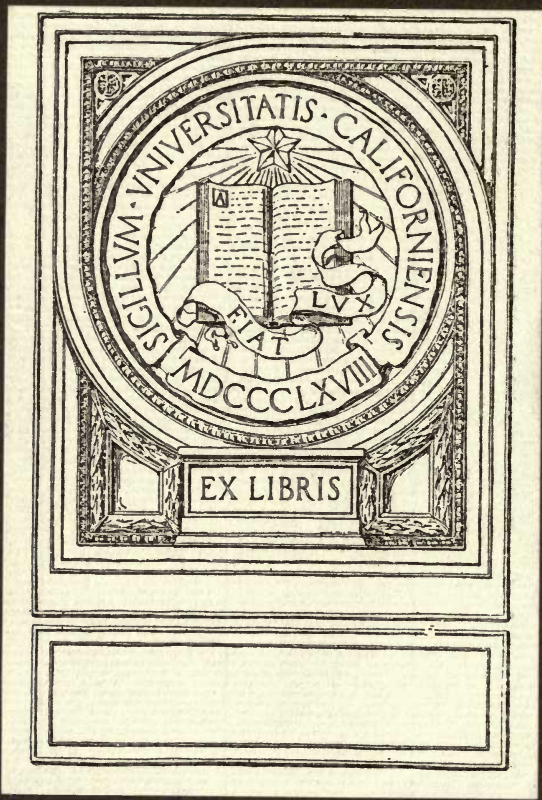
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NEW SERIES, VI.

THE BOTANY OF THE APPLE TREE.

By Charles E. Bessey, Ph. D.

ASSISTED BY ALBERT F. WOODS, A. M.

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THE BOTANY OF THE APPLE TREE.

BY CHARLES E. BESSEY, ASSISTED BY A. F. WOODS.

The apple tree is a near relative of the roses, raspberries, blackberries, strawberries, and is somewhat further removed from the plums, peaches, cherries, etc. It is therefore a member of the rose family (*Rosaceæ*), and has many characteristics common to the one thousand related species.

The place of this family among the flowering plants of the vegetable kingdom has been a matter of some controversy, but the more rational view is the one which regards its species as standing not far from the lower or primitive dicotyledons (*i. e.*, plants with two seed leaves), and hence not distantly related to the buttercups, anemones, etc. Indeed it is not difficult to see in the strawberry, raspberry, and blackberry, and even in the apple itself, a good many resemblances to buttercups and anemones. If the receptacle of a buttercup should become fleshy we would have a pretty close imitation of a strawberry. If we compare the species of Spiræa with some of the members of the buttercup family, the resemblance is still more striking. It is safe for us to assume, therefore, that the family of plants to which the apple belongs is not one of high botanical rank, however high we may rank it from an economic standpoint.

In the rose family there are several marked types of flowers, of which the most important are the following: (1.) With several, separate, free pistils, as in the strawberry, blackberry, raspberry, Spiræa, etc. (2.) With several pistils which are covered with the adherent calyx-tube, as in the apples, pears, quinces, etc. (3.) With but one free pistil, as in cherries, peaches, plums, etc.

The plants of the second type are sometimes set off in a sub-family called the apple sub-family (*Pomaceæ*), and occasionally this has been regarded as a distinct family under the same name. In the apple sub-family botanists have been able to distinguish fourteen different genera, of which the most important from the horticulturist's standpoint are the following: *Cotoneaster*, of which one or more species are in common cultivation as pretty, thorn-like trees; *Cydonia*, the quinces; *Pirus*, the apples; *Eriobotrya*, the Japanese medlars; *Amelanchier*, the service berries; *Mespilus*, the common medlars; and *Cratægus*, the hawthornes. In this paper we are particularly concerned with the genus which includes the apples, and, as will be seen below, even here we need notice but a few of the many species.

PIRUS L.

Flowers containing both stamens and pistils; calyx a five-lobed cup adhering to and enclosing the two to five ovaries; petals five, inserted on the top of the calyx cup; stamens many (about 20) inserted on the top of the calyx cup; ovaries usually with two ovules, producing as many seeds; fruit, a pome, consisting of the enlarged and fleshy calyx cup, enclosing the papery carpels (core) and brown, tough-coated seed; leaves alternate, deciduous, simple or compound.

About fifty species of this genus are now known, mostly natives of the north temperate zone, a few extending into the tropics upon high mountains. Seven or eight species occur in North America.

The genus is divided into six sub-genera, namely:

1. *The Apples* (*Malus*), with globose fruit, containing soft flesh; leaves simple.
2. *The Pears* (*Eupirus*), with pear-shaped fruit, containing granular flesh; leaves simple.
3. *The Beam-Trees* (*Aria*), with pear-shaped or globose fruit, containing granular flesh; leaves simple.
4. *The Choke-Berries* (*Aronia*), with berry-like, pear-shaped, or globose fruits, and simple leaves.
5. *The Dwarf-Apples* (*Micromeles*), with small apple-like, 2 to 3 celled fruits, and simple leaves.
6. *The Mountain Ashes* (*Sorbus*), with berry-like mostly 3-celled fruits, and compound leaves.

In this paper the species of the first sub-genus only will be noticed, inasmuch as they, alone, are properly entitled to the name "Apple." All the species considered here are of more or less horticultural interest.

THE APPLE SPECIES.

SECTION 1. Calyx-lobes persistent upon the ripe fruit; styles 5; fruits 5-celled.

A. Leaves folded in the bud, more or less pinnately lobed; flowers white or pink; trees more or less thorny.

1. EASTERN APPLE (*Pirus coronaria* L.) Leaves ovate to triangular-ovate, sharply cut-serrate, and often 3-lobed; twigs and leaves soon smooth; flowers on smooth pedicels; ripe fruit depressed-globose, yellow-green, 1 to $1\frac{1}{2}$ inches in diameter. A shrub 8 to 10 feet, or small tree 20 to 30 feet high. Native of North America, from New York to Michigan, and south to Georgia and Alabama, and frequently planted for ornamental purposes.

2. PRAIRIE APPLE (*Pirus ioensis* (Wood) Bailey). Leaves elliptic-oblong to ovate-oblong, irregularly and obtusely toothed; twigs and under surface of leaves white-woolly; flowers on white-woolly pedicels; ripe fruit depressed-globose, yellow-green, 1 to 2 inches in diameter. A shrub or tree like the preceding. Native of the Mississippi valley. This is probably the parent form of the "Soulard Crab," which Professor Bailey has described as *P. soulardi.*

3. SOUTHERN APPLE (*Pirus augustifolia* Ait.). Leaves lanceolate-oblong, coarsely and bluntly toothed; twigs and leaves soon smooth; flowers on smooth pedicels; ripe fruit depressed-globose, yellow-green, $\frac{3}{4}$ to 1 inch in diameter. A shrub or tree like the preceding, native from Pennsylvania to Florida, and west to the Mississippi valley, and frequently planted for ornamental purposes.

It is probable that the three foregoing species are but geographical varieties of one species, as they show easy gradations from one to the other. The Prairie apple appears to be the most valuable, and as a consequence it is the most promising as a stock for the development of cultivated varieties.

B. Leaves rolled in the bud, not lobed.

(*a.*) *Fruit crowned by the calyx lobes only* (*not by a tube*).

4. SMOOTH WILD APPLE (*Pirus silvestris* (Mill.) Koch). Leaves

ovate, crenate, when young hairy, when old smooth, or nearly so; twigs at first sparsely hairy, becoming smooth, flower-stalk and calyx mostly smooth; fruit yellowish or reddish, $\frac{3}{4}$ inch in diameter on a stalk about as long, very sour and bitter. A tree 25 to 30 feet high, native of central Europe.

5. HAIRY WILD APPLE (*Pirus malus* L.). Leaves ovate or elliptical, crenate, more or less hairy, as are the twigs also; flower-stalk and calyx white-woolly; fruit longer than its stalk, larger than the preceding, from sour to sweet. Two quite well marked wild varieties are commonly recognized as follows:

   var. *dasyphylla*, a tree of moderate size with horizontal branches, bearing large leaves (3 to 4 inches long and 2 to $2\frac{1}{2}$ broad). Native of the Orient.

   var. *pumila*, a shrub or small tree, native of southeast Russia, the Caucasus, Tartary, etc. From this variety have come the dwarf apples known as *Paradise* and *Doucain* apples, so frequently used by propagators for dwarfing the larger cultivated sorts.

This species with its varieties appears to have given rise to most of the cultivated apples of the world. It is doubtful whether the preceding species (*P. silvestris*) should be kept distinct from *P. malus.* They appear to freely intercross and produce gradations from one type to the other.

The cultivated varieties, as the Baldwin, Jonathan, Ben Davis, Grimes' Golden, are what the botanist calls "horticultural varieties," which differ from varieties in the botanical sense by being less stable. A botanical variety will reproduce itself from seed, but these "horticultural varieties" will not do so. And yet the two differ only in degree, not in kind. The horticultural variety is a slight temporary variation which will easily lose its identity, while the botanical variety is the same in kind, but with such stability that it reproduces itself year by year from the seed.

The extremely variable character of this species may be inferred from the statement made by Professor Bailey, that the horticultural varieties undoubtedly reach four or five thousand.* Downing gives

*See the article "Apple" in the new edition of Johnson's Cyclopædia, 1893, pp. 260–261.

descriptions of 1900 varieties, and the American Pomological Society's list includes 369.

(*b.*) *Fruit covered by a short fleshy calyx tube, bearing the calyx lobes.*

6. CHINESE APPLE (*Pirus spectabilis* Aiton). Leaves elongated-elliptical, smooth; flower-stalk and calyx-tube hairy; fruit about as long as its stalk (1 inch), yellowish. A tree 20 to 25 feet high, native of China and Japan, often found in cultivation, with much "doubled" flowers.
7. RINGO APPLE (*Pirus ringo* Seibold.). Leaves ovate-elongated, sharp serrate, at first hairy below, but eventually smooth; flower-stalk and calyx white-woolly; fruit wax-yellow with a reddish tinge, 1 to 1½ inches in diameter, stalk about as long. A small tree 9 to 10 feet high, native of Japan. Occasionally cultivated for ornamental purposes.
8. LARGE SIBERIAN APPLE (*Pirus prunifolia* Willd.). Leaves ovate, elongated or elliptical, smooth below, on long petioles; flower-stalk and calyx hairy or smooth; fruit wax-yellow, to red and even black, 1 to 1½ inches or more in diameter, stalk about as long or longer. A tree 25 to 30 feet high, native of northern China, Tartary, and southern Siberia. This is the parent form of the larger cultivated crab apple, such as the *Transcendent, Hyslop,* etc.

SECTION 2. Calys lobes falling off after blossoming; styles 3 to 5; fruits 3 to 5 celled.

A. Leaves rolled in the bud.

9. SMALL SIBERIAN APPLE (*Pirus baccata* L.). Leaves elongated-ovate, smooth, as are the twigs also; flower-stalk and calyx smooth; fruit small, ⅓ to ¾ inch, yellow or red, on a much longer slender stalk (1 to 1½ inches). A tree 25 to 30 feet high, native of the Himalayas, Amur, China, and Siberia. This is the parent form of the smaller cultivated crab apples, as the Red Siberian Crab, etc.*

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*Since the preparation of this paper I have seen Dr. Alexandre Batalin's paper, "Notæ de Plantis Asiaticis," in *Acta Horti Petropolitani*, Vol. XIII (1893), pp. 91 to 106, in which he describes another apple from the province of Kansu in western China, which is apparently allied to *Pirus baccata*, and which he names *P. transitoria*. It is a tree about 20 feet in height, with long-petioled, trisected, or tripartite densely pubescent leaves, and a small globose fruit, about ½ inch in diameter. It should be investigated by our horticulturists, as a possible stock for top grafting.

B. Leaves folded in the bud.

10. TORINGO APPLE (*Pirus toringo* Koch). Leaves small, ovate or elongated, 3 to 5 lobed; flower-stalk and calyx sparingly hairy, or smooth; fruit small spherical, $\frac{1}{4}$ inch in diameter, on a long stalk. A small tree 12 feet high, native of Japan, occasionally planted for ornamental purposes.

11. OREGON APPLE (*Pirus rivularis* Dougl.). Leaves ovate-lanceolate, smooth and firm, dark green, serrate; flower-stalk and calyx somewhat hairy, or smooth; fruit on long stalks obovate oblong, $\frac{1}{2}$ to $\frac{3}{4}$ inch long, from yellowish-green to yellow and even red, flavor "a pleasant sub-acid." A tree 30 to 40 feet high, native of the Pacific coast of North America from California to Alaska. This species should receive the attention of the scientific horticulturists of the western coast states.

REMARKS ON THE FOREGOING SPECIES.

From this view of the species noticed above it is seen that three are natives of eastern North America, one of western North America, two of Europe, three of China and Japan, and two of the Siberian region. Of these we have brought into cultivation for their fruits one species from eastern North America, one or two from Europe, and two from the Siberian region. The species from China and Japan are ornamental, as are also those from North America. These facts may be shown more clearly by the following table:

No.	Name.	Nativity.	Cultivated or Not.
1	Eastern apple	Eastern North America..........	For ornament only.
2	Prairie apple..........	Mississippi Valley	For ornament and for fruit.
3	Southern apple........	Southern states ...	For ornament only.
11	Oregon apple..........	Pacific coast of North America..	Sparingly cultivated for ornament.
4	Smooth Wild apple..	Europe	Probably cultivated for its fruit.
5	Hairy Wild apple.....	Europe	Cultivated for its fruit.
6	Chinese apple	China and Japan..	Cultivated for ornament.
7	Ringo apple............	Japan	Cultivated for ornament.
10	Toringo apple	Japan	Cultivated for ornament.
8	Large Siberian apple	Siberia, Tartary, and China........	Cultivated for its fruit.
9	Small Siberian apple	Siberia, Amur, and China	Cultivated for its fruit.

THE TREE IN HEALTH.

The healthy apple tree derives a portion of its food from the soil into which its roots penetrate. This food consists of various substances, the chief of which is water, in which all the other food substances are dissolved. No substance is taken up by the roots in a solid state, but in every case the food from the soil must be dissolved in water before it can be absorbed. The particular organs of absorption are the younger portions of the small roots, and the minute hairs which clothe the surface of new roots. The statement still to be seen in popular books, and often repeated in some journals, that the watery matters in the soil are taken up by "spongioles" on the tips of the roots is a gross error. There is no such thing as a "spongiole" at the end of any of the roots, and it is strange how so palpable an error should have been continued for so long. The very tip of the root where the "spongiole" was supposed to be *takes no active part in the absorption of food matters from the soil.*

In addition to water itself, the other food-matters, are (1) some nitrogenous substances, (2) salts of lime, (3) salts of potash, (4) salts of phosphorus, (5) salts of iron, and probably small quantities of a few others. The nitrogenous substance may be a salt of ammonia, such as would be supplied by barn-yard manure, or it may be a nitrate such as manure supplies, as well as many of the commercial fertilizers. Most soils contain enough of the salts of lime and potash for the supply of the tree, but they do not all contain enough of the phosphorus and iron, and these may profitably be added to the soils in small quantities. Decaying bones and rusty scraps of iron in the soil will supply all that the tree requires.

The supply of food which the tree derives from the air is in certain respects more important than that which it obtains from the soil. The green leaves absorb carbon dioxide (commonly called carbonic acid gas) from the air, in which it exists in minute quantities. Carbon dioxide is a heavy, poisonous gas, composed of carbon and oxygen. It is produced in the burning of wood, oil, illuminating gas, and in fact it is one of the products of the burning of nearly all common substances. This gas is absorbed by the green leaves, entering through the little pores found in great numbers on the under surface. It may not be generally known that upon every leaf there are immense numbers of mouth-like pores, which open and close according as the conditions are favorable or not. Upon a fair-sized apple leaf, there are no less than from 350,000 to 400,000 of these pores, and in some cases they run much above these almost incredible figures. In some plants, as cottonwoods, sunflowers, cabbages, etc., they occur on both sides of the leaf, but in the apple they are confined to the under side. A tree is thus a thing with a myriad of mouths, through which it breathes in the carbon dioxide as one of the most important of its foods. It also takes in through its leaf-mouths another gas, some of which eventually becomes a part of the plant body, and hence it must be called a food matter. This gas is oxygen, the same gas which we take into our lungs with every breath we inhale.

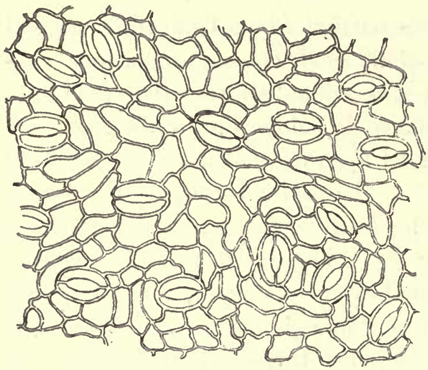

FIG. 1.—A small portion of the lower skin of an apple leaf, showing the breathing pores, magnified 725 times.

The carbon dioxide and a little of the water are broken up in the green cells of the leaves, and from the resultant fragments starch is made. The latter constitutes a more important secondary food of plants, inasmuch as it contains almost exactly the same substances as those which constitute the bulk of the solid part of the tree. Although starch is made in the green leaves, it may find its way to all parts of the tree, even to the remote roots away down under ground, and everywhere, sooner or later, it is used by the plant in the building up of its substance. At the same time the other food substances taken in by the roots are used by the different parts of the plant as needed. The idea sometimes advanced that all food matters taken in by the roots must go to the leaf in order to be "elaborated," is quite erroneous. These substances are used whenever they are needed, whether in the roots themselves, or in the twigs, or even the leaves of the tree top.

There is one thing which must be discussed at this point, although it is only indirectly connected with the question of the food of the tree. I refer to the loss of water from the aerial parts of the tree, and particularly from the leaves. It can easily be shown that the inside of a leaf is much more moist than the air which surrounds it;

there is, therefore, a constant tendency of the water to pass out into the air, and this would take place with great rapidity if it were not for the impenetrable skin which covers both surfaces. This skin keeps in the moisture of the leaves just as the oiled paper, which florists use so much, keeps in the moisture of the flowers. But, as stated above, there are breathing pores (or mouths) in the skin of the under side of the leaf, and when the plant opens these for taking in or giving off gases, some moisture escapes. When we remember how many of these openings there are in a leaf we can readily understand how easily the moisture can evaporate when they are open.

Now this loss of water must be made good or the tree will perish. When a leaf loses water its cells take moisture from the twigs; these in turn take from the branches, and these again from the trunk, and so on to the youngest roots which get their supply of water from the soil. There is thus a movement of the water toward the point where the loss occurs, and this movement is more or less rapid as the loss by the leaves is more or less. In damp weather there is little or no loss of water from the leaves, and as a consequence there is little movement of water in the tree. In the winter, also, there is little movement of the water, since evaporation is reduced to little or nothing.

From what has been said it may easily be made out that the tree has more water in it in the winter, when it loses little, if any, by evaporation, than in the summer, when its supply of water is constantly being reduced by the loss from the leaves, and careful experiments show that this is actually the case. There is more water in a given bulk of the tree trunk, or in the branches and twigs, in January and February than in June and July.

A word should be said here about the word "sap" as applied to the watery part of the apple tree. It is simply the water in the tree in which various substances are dissolved. Sap is not a living fluid; it is not a kind of vegetable blood. It is more like the watery mixture to be found in the alimentary canal of animals than like their blood, and yet this is not a good comparison to make, as it is likely to lead to false conclusions. Moreover, the sap is *not* a circulating fluid. It *does not* pass up and down in currents like the blood currents of animals, and last, but not least, it *does not* go down into the roots in the fall and come up in the spring.

The growth of the tree which is the most obvious to the horticulturist is that which annually proceeds from the bud. Now a bud is the stunted, inactive end of a shoot, and growth in the spring is simply the resumption of activity. Even the so-called lateral buds are in reality the ends of very short lateral shoots. When the growth of the previous year is checked, at the time that the bud forms there is a considerable deposit of food matter, generally starch, in the bud itself, or near it. On the advent of warm weather the starch becomes changed to sugar and is dissolved in the water of the tree when it is ready for use by the buds. Each bud, as it becomes sufficiently warmed, absorbs the sugary food and growth at once is resumed; the stem elongates, thus separating the bud scales and bringing out the young inner leaves. At the apex of the stem new stem and leaves are constantly produced, while below these are as constantly developing into their full grown adult form. For a time the growth at the apex of the stem excels that of the rest of the shoot, but after a time the apical growth diminishes, and, as a consequence, the young leaves become bunched at the end of the shoot in the form of a bud. The growth of a stem in length is thus an intermittent one, and the bud is simply the quiescent winter condition of its apex.

The leaf of the apple tree needs no description as to its external anatomy, as this is well known. Internally, however, its structure is not so generally known. It is composed of very small green cells, surrounded by a skin-layer of colorless cells, and penetrated by a supporting framework of branching ribs. The green cells next to the upper skin are elongated and closely packed side by side, with one end touching the skin. These are the so-called "palisade" cells of the leaf. In well grown leaves there are two or even three layers of palisade cells. Below these the cells are very loosely arranged, as is well shown in Fig. 2. Between all these internal cells there are free spaces which are occupied with air and other gases which entered through the breathing pores mentioned above, and shown in Fig. 1.

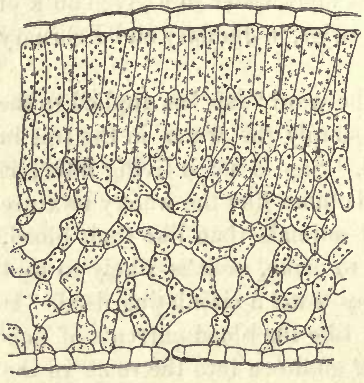

FIG. 2.—Cross section of an apple leaf, magnified 200 times.

It may serve to show the complexity of the apparently simple apple leaf to state that in a smallish leaf a little more than two and a half inches long there are fully *fifty millions of cells*, of which no less than *eight millions* constitute the skin of the two surfaces. In the skin of the lower surface there are from 350,000 to 400,000 openings, the breathing pores.

The growth of trunk and branches in thickness takes place in this wise: During the latter part of spring and early summer there is a great growth of soft cells between the wood and the bark, and immediately the outermost cells begin changing to bark and the innermost ones to wood. This continues until there is left but a thin layer of the soft cells. The next year this thin layer grows rapidly and forms a new mass of soft cells, which in turn develop into bark and wood, and so on. Usually there is but one great growth of these cells in each year, but in some seasons there are two growths, so that while there is commonly but one ring of wood formed each year, now and then there may be two.

In this connection it may be well to state that after a stem is ripened it does not elongate. All stories about the elongation of tree trunks are founded upon erroneous observations, or are willful falsehoods.

The growth of roots is, in nearly all respects, similar to that of the twigs and branches. Here, however, there are no buds. The end of the root is, however, much like the end of the stem inside of the bud. If we should compare the tip of the stem in the bud with the tip of the root, the difference would not be very great. Then, too, in the root, as in the stem, the elongation ceases as soon as it has become hard and firm. An old root never elongates its body. The growth in thickness of roots is precisely like that of the trunk and branches, and there are, consequently, similar annual rings of wood.

With all this growth year by year there is a constant death of tissues, which follows hard upon it. The layer of new wood is but feebly alive by the end of the season of growth, and the new bark is little, if any, better. The thin layer of soft cells between wood and bark, that remnant of the previous year's active cells, the *cambium* of the botanists, is all that retains much life. The pith and the medullary rays are but passive storehouses at the end of the first year's growth of a twig, and after that they are dead. In the buds the outer leaves ("scales") soon die, leaving the tiny central stem, and the inner leaves which alone are alive. In the roots the tip retains its vitality, but in the older portions there is left but the thin cambium between the feebly active layers of wood and bark.

The apple flower is too well known to require a full description, but the following summary may be useful:

There are in the first place five green leaves (sepals*) grown together at the base of the flower, and constituting the calyx.† On the top of the calyx are the five white or pinkish petals,‡ collectively called the corolla.§ Next there are twenty or more thread-like organs each with a yellowish head; these are the stamens,‖ and their heads contain a yellow powder, the pollen.¶ There are five seed-pods

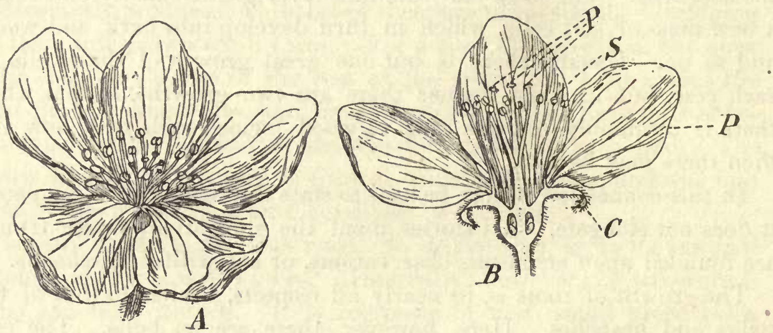

FIG. 3.—Flowers of the apple. A, fully open; B, cut vertically; C, the calyx; P, petals; S, stamens; P, stigmas at the top of the pistils.

(pistils**), but their bases are covered by the calyx-tube, leaving only their elongated hairy styles, each capped with its flattish stigma (as shown in Fig. 3 at P). In the lower portion of each pistil there are usually two young seeds (ovules).

In order that the fruit and seeds may develop it is necessary that the ovules should be fertilized. This is done by the pollen when it is placed upon the stigma of the seed-pod, where it grows down the style to the ovule. The result of fertilization is the formation of seeds, and the development of much fleshy tissue in the calyx-tube

* Pronounced sep′-als.
† Pronounced ca′-lyx.
‡ Pronounced pet′-als.
§ Pronounced co-rol′-la.
‖ Pronounced sta′-mens.
¶ Pronounced pol′-len.
** Pronounced pis′-tils.

surrounding the seed-pods. Unless there is fertilization, therefore, there will be no apples. Now, while every apple flower has pollen in its stamens, it is a well known fact that the fertilization is usually effected by pollen from another flower. This is due to the fact that when the flower first opens, its stamens are not quite mature, while the stigmas are ready to receive pollen. It thus happens that before the stamens of any flower are ready to supply pollen to the stigmas, the latter have received all they need from other flowers. This is effected by bees of various kinds which search the flowers for honey, their bodies in the meantime becoming covered with pollen which they leave upon the protruding stigmas of the successively visited flowers. It is probable that self-fertilization may take place, in the absence of insects; in fact Müller makes the positive statement that such is the case,* but this must occur under ordinary circumstances with comparative infrequency, since bees are very common, and at the time of apple-blossoming are eager to visit every honey-bearing flower.

It may occur, however, that heavy rains and violent storms may wash away the pollen before the bees have carried it from flower to flower. This I have known to occur more than once, and as a consequence the crop was very light. I have no doubt that even in such seasons many more flowers would be fertilized if every orchard contained a few strong swarms of bees.

The fruit of the apple consists, as has been already said, of the thickened and fleshy calyx-tube which surrounds and encloses the five seed-pods. At the top of the apple are to be found the remains of the calyx-tips, hence this is called the calyx-end of the apple, or in horticultural works it is commonly spoken of simply as "the calyx," and the depression in which it is, as the "basin."

At the opposite end is the stalk of the apple, originally the flower-stalk, now deeply sunken by the downward growth of the thick calyx-tube. The horticulturist speaks of the depression at the stalk end of the apple as the "cavity."

In a longitudinal section one may see lines extending through the flesh from the cavity to the basin (Fig. 4, A, W B); these are very small threads of woody matter, and may be designated as the woody bundles: they are in fact the remnants of the framework of the calyx,

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*The Fertilization of Flowers, by Prof. Hermann Mueller, English edition, page 238.

and correspond to the ribs and "veins" of ordinary leaves. In a cross section of the apple they show as little dots or points (Fig. 4, B, W B).

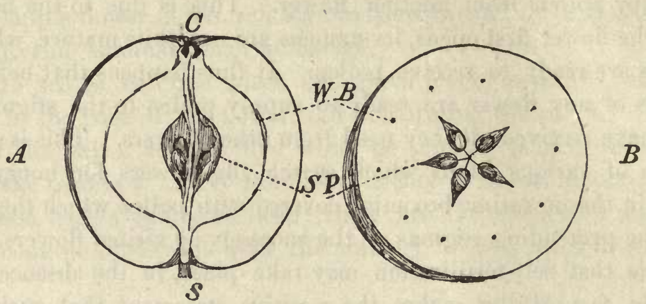

FIG. 4.—A, longitudinal, B, cross section of an apple; C, the calyx-tips (or "calyx") in the "basin"; S, the stalk, in the "cavity"; S P, the five seed-pods, or "core"; W B, the woody bundles of the calyx-tube.

Normally there should be two seeds in each seed-pod, thus making ten seeds for the whole core; but very commonly only one develops in each pod, and sometimes both are aborted. On the other hand, in some varieties, more than two seeds form in each pod. In a general way we may say that it is better for the fruit to have few seeds than many, as it requires much food to perfect seeds, which otherwise might be utilized in the fruit itself.

THE TREE DISEASED.

The apple tree, in common with all other living things, is subject to various diseases. Without attempting to enumerate all the diseases to which it is subject in different parts of the world, the following summary statement it is hoped will be helpful to a better understanding of its pathology: *

There are four general causes of pathological conditions in plants, all of which are factors in the pathology of the apple tree.

I. UNFAVORABLE HABITAT.—This includes not only such matters as height above the level of the sea, forest or plain conditions, etc., which may have much more influence than we suppose, but, also, the

* For a fuller discussion of the subject of plant diseases see the article "Pathology" (Vegetable), in the new edition of Johnson's Cyclopædia, vol. VI, from which much of what is here given is derived.

particular conditions of the soil. A soil may be wanting in certain substances necessary for the food of the tree: the result will be the starvation of the tree. But a soil may be fertile and still not supply enough food. If so hard that the roots cannot penetrate it, the tree is starved as certainly as in a barren soil. Or if the soil is too dry starvation will result, here intensified by the lack of water, the most important of the food substances. But on the other hand, in a soil which is too wet the tree is starved again, because its roots are injured by submersion, while the coldness of such a soil also acts deleteriously, both resulting in an under supply of food. The presence of excessive amounts of potash (and some other salts) in the soil may destroy the young roots, resulting again in starvation.

II. Unfavorable Atmospheric Conditions.—When the air is very dry the loss of water from the leaves is excessive and may exceed the supply obtained by the roots from the soil. Upon the plains the prolonged periods of high dry winds are peculiarly trying to all vegetation, and especially so to such trees as the apple, which has not only to meet the water-loss from its leaves, but also that from its flowers, and afterwards from its crop of fruits which remain on the trees during the summer. No doubt our trees are much more enfeebled from this cause than we are wont to believe. We know that a greenhouse plant which is kept for a long time in a semi-wilted condition is eventually much injured, and there can be no doubt that the same is true of apple trees.

It is possible that occasionally the temperature of some parts of the tree may rise too high, but upon this point we still lack sufficient data. I have no doubt, however, that in hot summer days the exposed trunks reach a dangerously high temperature.

The reverse condition of extremely low temperature, which is reached in many winters, is equally dangerous. A healthy apple tree will endure 20 or more degrees below zero of Fahrenheit, and some varieties will survive 40 or even 50 degrees below zero. Yet the experience of many Iowa apple growers twelve or fourteen years ago, who lost in one disastrous winter all the trees they had successfully grown for twenty years, must be a warning to us.

A quick alternation between a low and a high temperature is usually fatal to parts of living plants. This is probably the cause of "sun scald." When the frozen tree is suddenly thawed out by the bright winter's sunshine upon the trunk, to be as suddenly frozen again at night, the result is usually fatal to the cells of the cambium cells and those of the young wood and bark.

III. Mechanical Injuries.—Aside from wounds by natural causes, as the breaking of branches and leaves, injuries by hail, wind, and lightning, many wounds are made by man himself, as in pruning, pinching back, grafting, budding, etc. All these wounds, whether made purposely or not, afford ready means for the access of bacteria and fungi, resulting in more or less extended decay of the tissues. Even when a wound is covered by the growth of living tissues over it, decay usually continues, extending deeper and deeper until it becomes widespread. There can be no question that every wound is a serious menace to the life of the tree.

Under this head must be placed all the injuries by insects. These affect all parts of the tree, the roots, trunk, branches, twigs, flowers, and fruit. In many cases the injury is one of simple cutting, as in the removal of parts of the leaves, the boring of the stems, etc., but if the loss of leaves is excessive the tree may perish through starvation, and the burrows in the stems may afford means for the entrance of bacteria and fungi. Sucking insects by the withdrawal of water and other food matters in so far decrease the nutrition of the plant. Some insects, in addition, inject a poisonous or irritating fluid into the wood, killing the tissues or setting up abnormal growths, resulting in the production of galls and other malformations.

IV. Parasitism.—One of the most fruitful sources of diseased conditions in the apple tree is the presence of parasitic vegetable organisms in its tisues. More than one hundred fungi have been enumerated as growing upon the various parts of the tree, including the flowers and fruit, a great majority of which are parasitic. The diseases which they cause may be best discussed under the following heads:

DISEASES OF ROOTS.

Root-rot.—This is a serious disease in which the roots undergo a kind of dry-rot without any apparent cause. It is probably due to the presence of a fungus, since in other trees with a similar rotting of the roots the trouble has been traced to some of the larger fungi.*

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*See H. M. Ward's *Timber and Some of Its Diseases*, p. 142.

DISEASES OF THE TRUNK.

Rotten Heart.—This is probably closely related to the root-rot. The heart wood becomes brittle and punky, and may be easily snapped off with a little force. The threads of some of the larger fungi are found ramifying through the woody tissues. It may be that several fungi (pore-fungi, and toadstools) are concerned in this disease. Certain it is that a small ear-shaped toadstool (*Schizophyllum commune*) always appears on the trunk about the time that the disease is well under way. Another umbrella-shaped toadstool (*Agaricus melleus*) is known to be concerned in the heart-rot of various timber trees,* and it is thought by many botanists to be the chief cause of the present trouble.

It is probable that the fungi of Rotten Heart enter through wounds from careless and injurious pruning. It is possible that they may enter through the wounds made by grafting. These points demand careful inquiry.

Black Heart.—The cause of this common disease is obscure. It may be due to too low a winter temperature, and again it may be the effect of the earliest invasion of fungal filaments. Possibly it is the result of some of the other general causes discussed above. It demands further study.

Sun Scald.—While not due to parasitism, this is entered here in order to refer the reader to the discussion above under "Unfavorable Atmospheric Conditions."

Blight.—Twig-blight sometimes extends down upon the trunk of the tree.

See the following discussion of blight on twigs and branches:

DISEASES OF THE BRANCHES AND TWIGS.

Blight.—The following account of the blight of the apple tree is supplied by Mr. A. F. Woods, until recently assistant in the botanical department of the State University, now assistant pathologist in the Department of Agriculture, Washington, D. C.:

THE "TWIG BLIGHT" OR "FIRE BLIGHT" OF THE APPLE.

This disease is best characterized by the dying of the twigs from the end down. In severe cases the smaller limbs are often attacked,

* H. M. Ward's *Timber and Some of Its Diseases*, p. 155.

and sometimes the larger limbs, and even the trunk of the tree is killed. The same disease attacks the pear, and is known as the "pear blight." It is much more severe and destructive on the pear than on the apple. It has a wide distribution in North America and is the cause of great loss to apple and pear growers.

Cause.—The disease is caused by a certain minute single-celled plant, one of the bacteria named *Micrococcus amylovorus* by Professor Burrill, but since called *Bacillus amylovorus* (B.) De Toni. Professor Burrill* first discovered that this bacterium was the cause of twig-blight. He inoculated healthy branches with the juices of diseased ones, thus being able to produce the "blight." Dr. J. C. Arthur,† by a series of very carefully conducted experiments, proved beyond doubt that the disease is caused by this particular bacterium and by no other. *Bacillus amylovorus* (B.) De T. is very small, *one to one and one-fourth* thousandths of a millimeter long, by half as broad. They are oval and colorless, either single or attached in twos or threes. One or more of them gain entrance into the young succulent parts of twigs or into the flowers, increase in numbers and destroy the young growing cells of the twigs or flowers, thus causing their death.

FIG. 5.—Bacteria which produce blight, magnified 1,000 times.

Infectious.—The disease is considered to be extremely infectious, the bacteria being carried in the form of dust from tree to tree by the wind. Mr. M. B. Waite, of the Division of Vegetable Pathology in the United States Department of Agriculture, has pointed out the fact that insects play a very important part in distributing these germs. He doubts if any other very important means of distribution exists.

Species of trees affected.—The disease is most troublesome in the pear, apple, and quince, but affects many other near relatives of these. The different varieties of apples are affected in different degrees.

Conditions—It is generally held by investigators and those acquainted with the disease, that watery, succulent growth offers the best conditions for the development of the disease.

Remedy—Removal and destruction by fire of the diseased parts is, so far as yet known, the best remedy. Anything that will cause hardy

*Proc. Amer. Assoc. Adv. Sci., vol. XXIX, 1880, p. 583.

†Proc. Amer. Assoc. Adv. Sci., vol. XXXIV, 1885, p. 295.

growth instead of watery, succulent growth aids the tree in resisting attack.

During the month of October, 1892, the Botanical Department of the Agricultural Experiment Station of Nebraska sent out a list of questions with the object of bringing together the experience of our horticulturists concerning "twig-blight" of the apple. There were *one hundred and three* sets of questions sent out and fifty sets were returned with most of the questions answered. While the Department regrets that there were not more answers received, still it believes the results of the inquiry to be of practical value to the fruit growers of the state and may at least serve as a foundation for a more complete record.

Record of Answers to Questions 1 and 2.

(1.) What varieties of apples have you found least affected by this disease, and (2) what varieties most affected?

Name.	Least affected.	Not badly affected.	Most affected.
1. Allen's Choice	2	0	0
2. Autumn Strawberry	0	1	0
3. Autumn Swaar	0	0	1
4. Baldwin	0	0	1
5. Ben Davis	23	1	2
6. Brier's Sweet Crab	0	0	1
7. Bentley's Sweet	1	0	0
8. Buffington's Early	2	0	0
9. Carolina Red June	1	1	2
10. Chenango Strawberry	2	0	2
11. Cole's Quince	2	1	0
12. Cooper's Early White	0	0	7
13. Day	1	0	0
14. Dunlap	1	0	0
15. Duchess of Oldenburg	19	2	0
16. Domine	0	0	13
17. Dyer	1	0	0
18. Early Harvest	5	0	1
19. Early Pennock	0	0	1
20. Fall Wine Sap	2	1	0
21. Fameuse (Snow)	1	0	11

Name.	Least affected.	Not badly affected.	Most affected.
22. Fulton	1	0	0
23. Gano	1	0	0
24. Golden Russet	0	0	4
25. Grimes' Golden Pippin	1	1	3
26. Haas	7	0	0
27. Hollow Core	1	0	0
28. Hubbardston's Nonesuch	1	0	0
29. Hyslop Crab	1	0	8
30. Huntsman Favorite	0	0	1
31. Iowa Blush	9	0	0
32. Jonathan	4	2	6
33. Lawver	0	0	2
34. Maiden's Blush	1	1	1
35. Mann	0	0	4
36. Minkler	1	0	1
37. Missouri Pippin (Nickajack)	1	3	8
38. Milam	1	0	0
39. Monarch	0	1	0
40. Mother	1	0	0
41. McAfee's Nonesuch	0	0	2
42. Northwestern Greening	2	0	0
43. Northern Spy	3	0	0
44. Otoe Red Streak	2	0	0
45. Perry Russet	8	0	2
46. Pewankee	1	0	5
47. Plumb's Cider	2	0	0
48. Price's Sweet	1	0	0
49. Pomme Grise	1	0	0
50. Rawle's Janet	13	4	2
51. Randel's Best	1	0	0
52. Red Astrachan	4	0	4
53. Roman Stem	2	0	0
54. Rome Beauty	2	1	2
55. Rambo	0	0	3
56. Salome	3	0	1
57. Sheriff	2	0	0
58. Small Red Romanite	6	0	0

Name.	Least affected.	Not badly affected.	Most afiected.
59. Smith's Cider	1	0	1
60. Sops of Wine	3	0	0
61. Stark	0	0	8
62. Summer Queen	0	0	1
63. Sweet June	3	0	0
64. Sweet Pearmain	1	0	0
65. Sweet Pear Apple	0	0	1
66. Trenton Early	1	0	0
67. Talman's Sweet	0	0	10
68. Tetofsky	0	0	3
69. Transcendent Crab	0	0	13
70. Utter	6	0	0
71. Walbridge	14	1	0
72. Wealthy	14	1	2
73. Westfield Seek No Further	2	0	0
74. Whitney No. 20, Crab	6	0	1
75. Wine Sap	24	0	3
76. William's Favorite	1	0	0
77. Willow Twig	1	1	12
78. Wagner	0	0	1
79. White Winter Pearmain	0	0	3
80. Yellow Transparent	0	0	5
81. Yellow Bell	1	0	0
Nearly all Russian Varieties	0	1	5
Nearly all Crabs	0	0	7
Hybrids	0	0	1

Taking out those varieties that have at least six favorable reports with very few or no unfavorable reports we have in the order of freedom from disease:

1. Duchess of Oldenburg.
2. Wine Sap.
3. Ben Davis.
4. Walbridge.
5. Wealthy.
6. Iowa Blush.
7. Haas.
8. Rawle's Janet.
9. Small Red Romanite.
10. Utter.
11. Perry Russet.
12. Whitney No. 20.

For those most affected we find in order named:

1. Transcendent Crab.
2. Domine.
3. Talman's Sweet.
4. Willow Twig.
5. Fameuse (Snow).
6. Stark.
7. Hyslop Crab.
8. Cooper's Early White.
9. Missouri Pippin.
10. Yellow Transparent.
11. Golden Russet.
12. Pewaukee.

Both of these lists might be greatly enlarged were there more data at hand. It is evident from the reports thus far compiled that very few, if any, of the eighty-one varieties named are entirely free from the disease under all conditions. Again, there are some generally reported as "bad blighters" that appear in the list as "least affected." These facts indicate the possibility of so controlling the growth of the tree that it may successfully resist the attack of the blight bacteria.

THIRD QUESTION.—What do you do to check the twig blight?

Cut and Burn.

In answer to this question there were twenty-one correspondents who "cut out and burned the blighted parts, thus controlling the disease with fair success." There were three who also "cut out and burned the bad blighters." There were three who, "in addition to the destruction of blighted parts and blighters, also stopped cultivation and seeded to clover." Two correspondents said "cut out and burn the blighted parts when the trees are through blighting."

Spraying.

There were three correspondents who used spraying mixtures, two "with no success," and one who did not say whether successful or not.

Root Pruning.

Root pruning is said by one correspondent to have been "successful in checking blight in Talman's Sweet in the orchard." Another correspondent "root pruned in the nursery row."

Salt and Lime.

One correspondent used a liberal application of "salt and lime to the surface of the soil." Another used "lime, ashes, and manure."

Nothing.

Six correspondents did nothing, and seven gave no answers to this question.

FOURTH QUESTION.—Have you noticed anything in regard to locality, slope, altitude, protection, soil, etc., that favors or checks the disease?

Conditions Favorable to Blight.

"Trees in rich and hot moist localities," reported by seven correspondents as "blighting the most." Two correspondents reported "blight worst in wet seasons." Six correspondents said "trees protected by timber belts so as to prevent free circulation of air blighted most." Three reported "southern slopes favorable to blight," and one reported "severe pruning followed by the disease."

Conditions Unfavorable to Blight.

Five correspondents reported "trees on high rolling ground" as "least affected." Five correspondents reported "trees on northern slopes not so badly affected as those on southern slopes." The three who reported against southern slopes should be considered here, making eight in favor of northern slopes as opposed to southern. One correspondent said that "a wind-break on the south of the orchard aids in reducing the blight."

FIFTH QUESTION.—Are young and old trees affected to the same degree?

Twenty-two correspondents reported "young and old trees affected to about the same degree." Six correspondents reported "young trees most affected." Four reported "old trees most affected." Sixteen correspondents gave no answers to this question.

SIXTH QUESTION.—What did you estimate your annual loss to be by this disease?

Seven correspondents reported "loss small on account of destruction of diseased parts." Two reported "loss small on account of planting non-blighters." Eleven correspondents reported an average loss of "five to ten per cent." More than ten per cent (fifteen to fifty), mostly in the nursery row, reported by five correspondents. "Loss small with no care taken," reported by two correpondents. Four correspondents said that their trees were "not troubled with blight," and sixteen gave no answer to this question.

Summary.

In bringing together the results of this inquiry in the form of a summary, I shall simply indicate, with few comments, the direction of the evidence gathered above.

Varieties Affected.

The evidence indicates that certain varieties of apple trees are less affected than others, but that few if any varieties are *proof* against the disease.

Conditions.

It appears that such conditions as hot, moist locality, rich soil, lack of free circulation of air (on account of protection by wind-breaks, etc.), cause a watery or succulent growth of the tree which is favorable to blight.

On the other hand, high rolling, well drained ground of north slope and free circulation of air offers the most favorable conditions for hardy growth of the trees, which are therefore less liable to blight.

How to Check the Disease.

So far as yet known the best way to check the disease is to cut off the blighted twigs several inches below where they are dead and burn them immediately.

Root pruning may cause a decrease in the water supply and thus be valuable in checking the succulent growth, but in many cases, especially in nursery stock, this is objectionable, because it is too great a check to growth.

Stopping cultivation and seeding to clover may check too rapid growth. The effect on the tree of *salt, lime,* and *ashes* applied to the surface of the ground needs further investigation.

Spraying has thus far proved to be of no value in checking the "Fire Blight" in diseased trees or in protecting them from attack.

Finally, if you are going to plant an orchard and wish to guard against "blight," the indications are, for Nebraska: *First,* plant varieties *least liable to blight; second,* plant on *high, rolling, well drained* ground of *northerly* slope; and last, plant no wind-breaks, except possibly on the south or southwest, at some distance from the orchard.

Black Heart.—Both branches and twigs are subject to this disease, which is discussed under the "Diseases of the Trunk."

DISEASES OF THE LEAVES.

Powdery Mildew.—The leaves of young trees, especially those in the nursery, are quite subject to the attacks of a powdery mildew which covers their surface with a white powdery coat. The leaves soon become somewhat curled and wrinkled, and eventually are greatly injured. The fungus which causes this disease is one of the Simple Sac-Fungi (*Perisporiaceæ*) and bears the scientific name of *Podosphæra oxycanthæ.* It consists of slender, white, branching threads which creep over the skin of the leaf, sending in little suckers here and there, which take food matter from the cells. At length many branches are sent up at right angles to the surface (Fig. 6, A). These

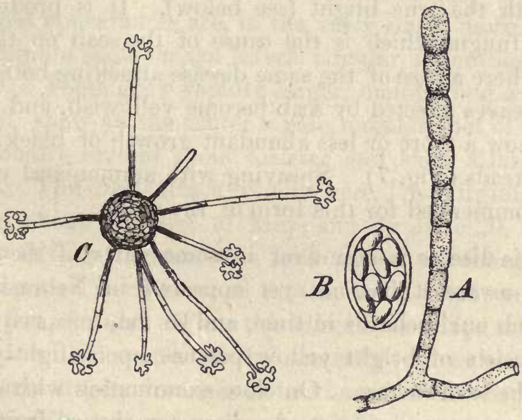

FIG. 6.—The Powdery Mildew. A, fragment of a thread with a vertical branch producing summer spores; B, spore-sac from the fruit; C, one of the ripe fruits with its radiating appendages. All much enlarged.

quickly break up into summer spores, and as these form in great numbers they give the leaves the well-known white-powdery appearance. The summer spores blow away in the wind and under favorable conditions germinate quickly and give rise to a new growth of the fungus. Later in the season, usually not until the autumn, the fungus produces its small spherical fruits (Fig. 6, C), which are black in color and barely large enough to be seen with the naked eye.

In the interior of each fruit there is at maturity a single spore-sac (Fig. 6, B) containing eight roundish spores. The thick wall of the fruit, and the thickish wall of the spore-sac, form a sufficient protection to the spores, which are thus enabled to pass the winter unharmed. The next spring they germinate in the masses of decaying leaves, and thus easily infect the lower leaves of seedling trees, from which they readily pass to older trees.

Burning the leaves in the fall or early winter will reduce the liability to the propagation of the disease next year.

Spraying the trees several times in the early part of the year, as soon as the disease appears, with a watery solution of the ammoniacal carbonate of copper* will kill the fungus.

Scab.—The disease of the leaves here referred to is known also as "leaf blight," a term of doubtful propriety, as it is liable to lead to confusion with the true blight (see below). It is produced by the same minute fungus which is the cause of the scab on the fruit; in fact we have here a case of the same disease attacking both leaves and fruit. The leaves affected by scab become yellowish, and on the under surface show a more or less abundant growth of blackish, jointed, branching threads (Fig. 7). Spraying with ammoniacal carbonate of copper is recommended for this form of the scab.

Rust.—This disease is abundant in some parts of the east, but so far as I am aware it has not yet appeared in Nebraska. It will doubtless reach our orchards in time, and so may properly be noticed here. It consists of bright yellow patches upon slightly thickened portions of the leaf surface. On close examination with a hand lens these patches are seen to consist of yellow cup-shaped fruits of a fungus which grows in the interior of the leaf, finally rupturing the skin to bring the spores to the surface. The spores germinate, not on apple leaves as might be supposed, but upon the red cedar, producing the kind of rust on it known as "cedar apples," and the spores from the latter infect the apple leaves again.

When abundant it is a most serious disease. It is noticed here in order to forewarn our orchardists. On its first appearance the trees

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* Ammoniacal carbonate of copper is prepared as follows:

Carbonate of copper	5 ounces.
Ammonia (liquid)	3 pints.

Mix thoroughly until the copper is dissolved.

Add water	45 gallons.

must be sprayed with the ammoniacal carbonate of copper solution, and it may be advisable to watch the red cedar trees, also, pretty closely in the spring of the year for cedar apples. Spraying these trees, also, might be useful.

Brown Spot.—In some of the eastern states the leaves of apple trees are sometimes destroyed by a minute fungus (*Phyllosticta pirina*). While I have not myself seen the work of this parasite in Nebraska, specimens were collected at Lincoln three or four years ago by Mr. H. J. Webber, then assistant in the Botanical Laboratory of the State University, who makes the following record regarding it: "On apple leaves. Abundant and frequently destructive. November 12. Lincoln."* It is therefore certain that it is in the state, and it is probably only a question of time when our orchards will be seriously troubled by it.

Professor Alwood of Virginia describes it as follows: †

"The external appearances are, in the early stage, more or less numerous quite minute spots on the leaves, circular in outline, and of a brick-red color. These grow rapidly larger, maintaining a nearly circular form, and show at the center a pale, circular spot of straw-like color. Occasionally several spots coalesce and show a large area of diseased tissue. The first attack occurs here [in Virginia] shortly after blooming, about the first of May, and by June 20, the foliage first attacked is falling. About this later period the foliage becomes very seriously spotted from a second attack, and a third outbreak occurs about the last of July. Thus this disease develops three successive outbreaks in the course of the summer, and unless promptly treated in its early stages, promises to be the most serious disease of the foliage orchardists have had to contend with."

It is suggested that the careful burning of the leaves which fall from the trees may be useful in checking the rapid spread of this disease. Spraying the foliage with Bordeaux preparation ‡ at the time the tree is in bloom is recommended also.

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* Appendix to the Catalogue of the Flora of Nebraska, Second Edition, p. 16.

† Bulletin No. 17 of the Virginia Agricultural Experiment Station, 1892, p. 62.

‡ The Bordeaux preparation is made as follows for this use:

Sulphate of copper	4 pounds.
Fresh lime	5 pounds.
Water	50 gallons.

Dissolve the copper and the lime separately and then mix the solutions. This is what is known as a weak solution; it is usually made two or three times as strong.

Blight.—When the twigs are blighted the leaves die, hence it is commonly said that the leaves are blighted, although usually the trouble is in the twigs. See the discussion of Blight by Mr. Woods under "Diseases of Branches and Twigs," on preceding pages of this paper.

DISEASES OF THE FLOWERS.

Blight.—It frequently happens that the flowers of the apple suddenly wither and turn brown with no apparent cause, no insects whatever being present. An examination of a good many specimens from orchards within the state, as well as from without, shows that we have here a case of genuine blight produced by bacteria identical with those in the twigs. See the discussion of Blight by Mr. Woods under "Diseases of Branches and Twigs," on preceding pages of this paper.

DISEASES OF THE FRUIT.

Scab.—But few apples are entirely free from this disease. In its mildest form it produces little black specks on the skin, which do little or no harm, but when more virulent it forms large black patches and produces much distortion. The fungus which causes scab is composed of dark-colored, jointed, branching threads which creep over the surface, invading the superficial cells (Fig. 7). After the growth has continued for some time, if the conditions have been favorable, the fungus forms denser black patches in which it produces great numbers of spores (Fig. 8). The particular manner of growth of these spores is shown in Fig. 8, at B, and a few of the detached spores are shown at S. When this fungus makes good progress in its growth while the apple is still small it produces great distortion, but if its development is later the apple is but little changed in shape, as in Fig. 8.

The fungus is one of the so-called "Imperfect Fungi," and is known in science by the name of *Fusicladium dendriticum.* As stated above (under "Diseases of the Leaves") it is the same one which attacks the leaves. It lives perennially upon the bark of the twigs, and from these it easily passes to the leaves and young fruit. Infection takes place also through the growth of the spores, hence the burning of the leaves in the fall would be useful.

Professor Alwood, of Virginia, recommends spraying the trees in early spring before the opening of the buds with a solution of lye,* which he says he "has clearly demonstrated very materially checks the outbreak of scab." †

FIG. 7.—Apple scab. A, a magnified view of a cluster of small specks; B, portion of the fungus highly magnified; C, part of B magnified still more.

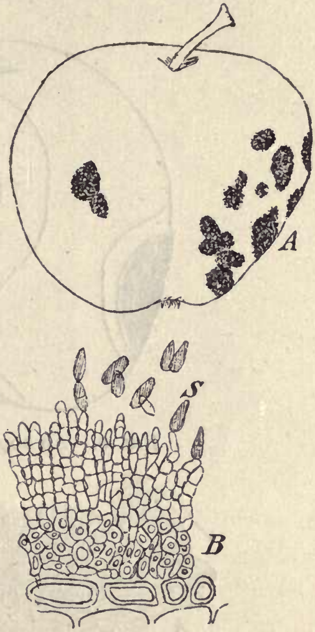

FIG. 8.—Apple scab. A, an apple with well developed scab; B, section through a scab highly magnified, showing a few detached spores at S.

Bitter-rot or Ripe-rot.—This troublesome disease appears upon the surface of the mature apple in the form of brownish or blackish spots which are at length studded with minute black points (Fig. 9). These diseased spots extend deep into the fruit, and are noted for having a peculiarly bitter taste. The fungus which produces bitter-rot is also one of the so-called "Imperfect Fungi," and is known as *Gloeosporium frutigenum.*

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* The solution used by Professor Alwood is made as follows:

Concentrated lye........	8 cans.
Water........	50 gallons.

† In Bulletin 17 of Virginia Agricultural Experiment Station, p. 64.

Professor Bailey recommends spraying the trees early in August with ammoniacal carbonate of copper.* Professor Alwood also recommends this, and further advises allowing hogs to eat up all affected apples, thus destroying the fungus. †

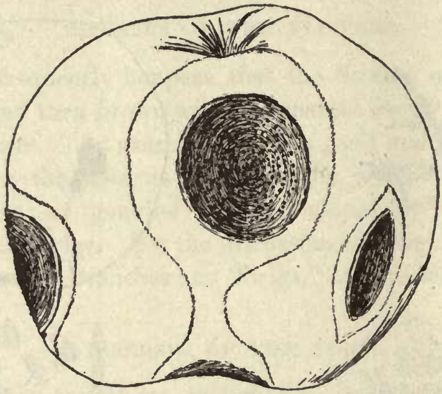

FIG. 9.—An apple affected with bitter-rot.

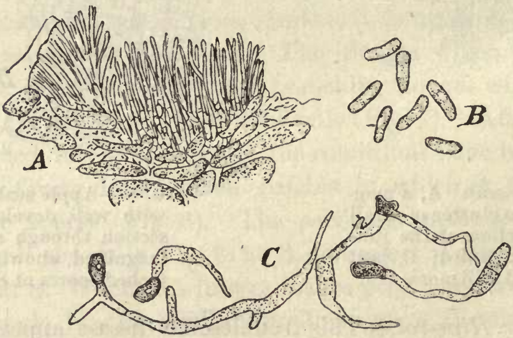

FIG. 10.—A, a magnified section through one of the dark points in Fig. 9, showing spore-bearing threads; B, more highly magnified spores; C, spores germinating.

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* In Horticulturist's Rule Book, p. 45.

† In Bulletin No. 17 of the Virginia Agricultural Experiment Station, p. 62.