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A New Apple Rot.

BY B. O. LONGYEAR.

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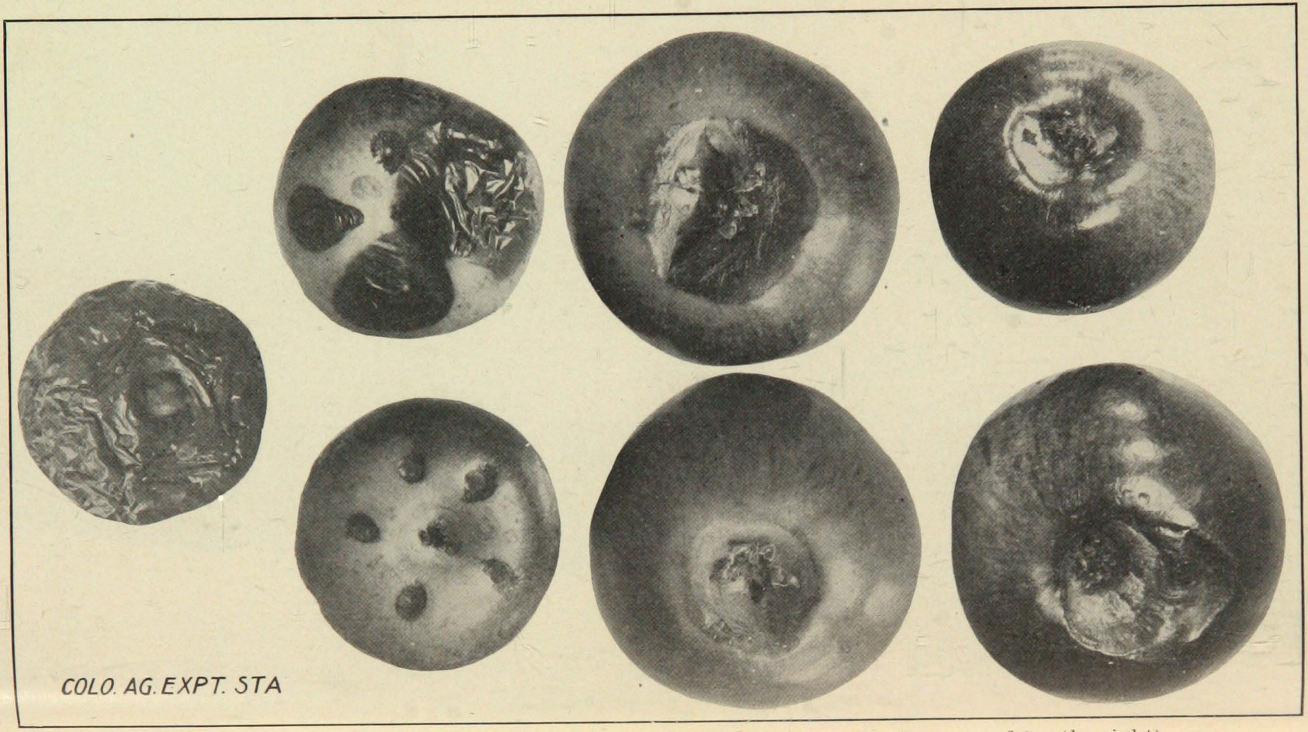


PLATE I.—Four Ben Davis apples showing the *Alternaria* Rot in the blossom end (on the right). Three apples artificially inoculated with spores of the *Alternaria* (on the left).

An Apple Rot Due to An Undescribed Species of Alternaria.

BY B. O. LONGYEAR.

HISTORY AND DISTRIBUTION.

Among the comparatively few diseases of orchard fruits, which occur in the state of Colorado, probably the most widely distributed and common one is a decay of apples and pears due to an apparently undescribed species of *Alternaria*. This decay was first met with by the writer at the Michigan Agricultural Experiment Station in the winter of 1904. While investigating the decays of stored apples at that place, a single specimen was found showing a decay of unfamiliar appearance. A tube culture was made from spores obtained by placing this specimen in a moist chamber for several days, and inoculations of sound fruit were made which demonstrated the ability of the fungus to induce the decay.

At this Station the fungus was first reported in November, 1902, and specimens were secured for study by Professor W. Paddock, who recognized the fungus as being a species of *Alternaria*. He also conducted some inoculation experiments with the fungus and made the first report of it in the Experiment Station report of 1904. Investigation shows it to be of quite common occurrence in this State and it has been also found in the core cavity of one variety of apples grown in California.

Thus, while this decay evidently occurs over a wide range, the fact that it has thus far been unnoticed, indicates that it is probably not destructive to any extent in other regions.

CHARACTER OF THE DISEASE ON THE APPLE.

In the case of the apple, so far as studied, the fungus is confined to the fruit, its most common point of attack being at the blossom end. The affected fruits usually show a dark purplish brown, slightly sunken area at the base of the sepals. This area may remain small and scarcely noticeable for a long time, but when the fruit is placed in storage it is apt to increase in extent until the fruit is entirely decayed. During the past season specimens were found in which the blossom end of the apple was cracked open and a considerable area of the discolored tissue surrounded the rupture, but this is not the usual manner of attack. It seems probable in

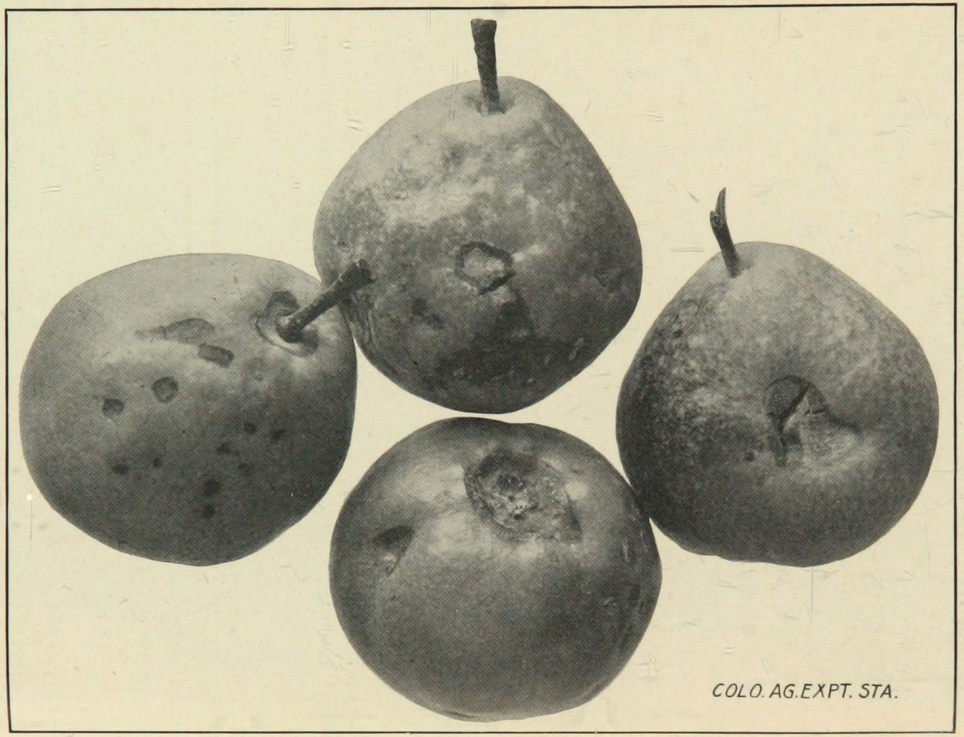


PLATE II.—Keiffer pears showing spotting and cracking due to the *Alternaria*.

these cases that the fungus was not the cause of the cracking, but merely gained a foothold in the wound. Other wounds in the fruit, such as those caused by the larvæ of the codling moth, are frequently the point of attack of this fungus.

The rotting due to this fungus is usually not so rapid as that caused by some of the soft rot fungi. Hence, fruit that is already affected by the *Alternaria* in some cases succumbs to some of the more rapidly working rots which not infrequently seem to follow it. The affected tissue is not greatly softened by this fungus, but by drying out finally changes to a shrivelled dark brown mass similar to that produced by the mummifying effects of the brown rot of stone fruits.

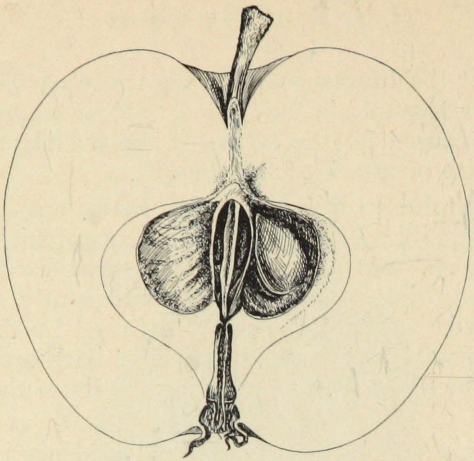
In many cases, however, no external evidence of the presence of the fungus is noticeable until the apple is cut through when the core cavity is found to be blackened or discolored. In the majority of such cases the parchment-like lining of the seed cavity is the only part showing the discoloration which, in mild cases, appears in the form of brownish or blackish streaks or stains. The seeds, too, are usually coated with a dark colored growth of the mycelium. In badly affected specimens, however, the seed cavity is nearly filled with fungous threads, while the discoloration extends into the surrounding flesh of the fruit to a greater or less extent.

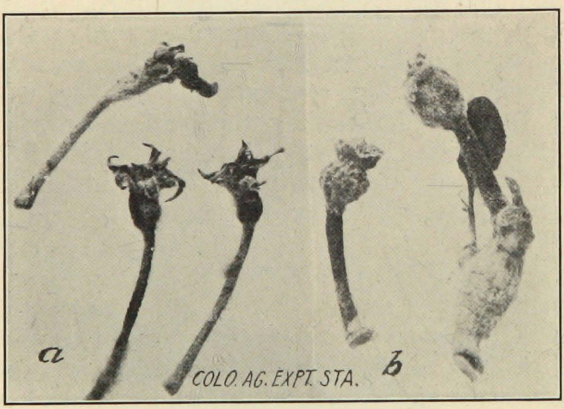
This invasion of the core by the fungus appears to be most common in certain varieties of the apple, among which the Wine Sap is especially subject to this form of attack. And in the worst cases this variety shows some evidence of the presence of the blackened core by a slightly contracted appearance and yellowed color of the blossom end. Fruit which is of good size and normal depth of color seems usually to indicate freedom from this condition of the core, while fruit of small size with unusually light or dark color is frequently found to be affected.

The reason why certain varieties of the apple are particularly subject to the blackened seed cavity is found in a structural peculiarity of such varieties. Thus a longitudinal section through such an apple usually shows a very deep calyx tube, which, in many cases, extends to or meets the core, or even opens into it. In such cases the fungus has evidently reached the core through this passageway by following the united styles and the inner wall of the calyx tube. (See Plate I and III).

ON THE PEAR.

In the case of the pear, the fungus has been found on fruit, leaves, and young sprouts at base of the tree. The fruit seems liable to attack at almost any point, in observed cases the stems being frequently blackened and the surface spotted irregularly. In the





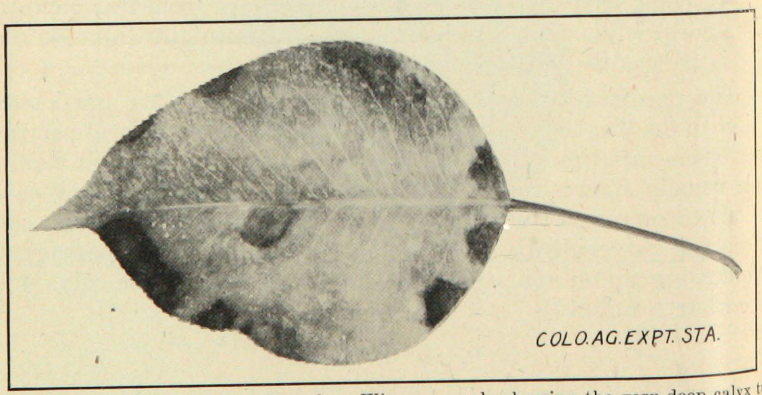


PLATE III.—Vertical section through a Winesap apple showing the very deep calyx tube meeting the seed cavity, which is darkened by the fungus (upper figure).

(a) Young apples, fallen from the tree, showing the *Alternaria* after being kept in moist chamber. (b) Young apples and a fruit spur blackened with the fungus, after remaining on the tree over winter.

Leaf of Keiffer pear affected with the *Alternaria* (lower figure).

latter case, too, the skin of the fruit is often cracked in the affected areas apparently from loss of moisture.

On the leaves of the pear the fungus produces brown spots of considerable size which are often situated along the margin or scattered over the surface in an irregular manner. (See Plate II and III).

MICROSCOPIC CHARACTERS.

The rotting effects of this fungus are due to the invasion of the tissues of the plant by numerous branching threads or hyphæ of mycelium. Thus a microscopic examination of the decayed part of an apple or pear reveals the presence of this mycelium in the form of an intricate network. These hyphæ vary considerably in diameter in some cases being so slender as to be seen with difficulty under even a high power. In numerous instances, the mycelium may be found in the cell cavity, in which case the slender hyphæ are often coiled to some extent. Within the affected tissues the mycelium is nearly hyaline, or but slightly yellowish in color and contains numerous minute oil drops; but as the fruiting or spore-bearing portions of the mycelium are reached, the hyphæ assume a brownish color. The conidiophores, or spore-bearing branches, possess rather thicker walls than the feeding part of the mycelium and are freely septate near the terminus.

The spores, conidia, are characteristic of those of the genus *Alternaria*. When seen in mass they appear blackish olive, but are of a brownish color when seen under the microscope. They differ much in size and shape, as well as in the number of cells composing them, varying from one cell in the smallest to ten or twelve cells in the largest. They are produced in simple or slightly branched chains with a narrowed portion, consisting of one or more lengthened cells, joining the spores. Thus, when the larger spores are separated they usually possess a somewhat flask-shaped form, the larger end representing the base or point nearest the conidiophore.

Spores may often be found by examining the calyx end of affected specimens of fruit, but are obtained most readily by placing such fruit in a moist chamber for a few days.

The spores germinate readily in water, each cell being capable of sending out a germ tube, and even portions of the conidiophores frequently act in the same manner. While the spores are capable of germinating as soon as mature, if conditions of moisture and temperature are not favorable they will remain dormant during the remainder of the season or until the conditions are suitable for growth. (Plate IV).

TIME AND MANNER OF INFECTION.

While the matter of infection has not been investigated to any great extent, it appears from observations made, in

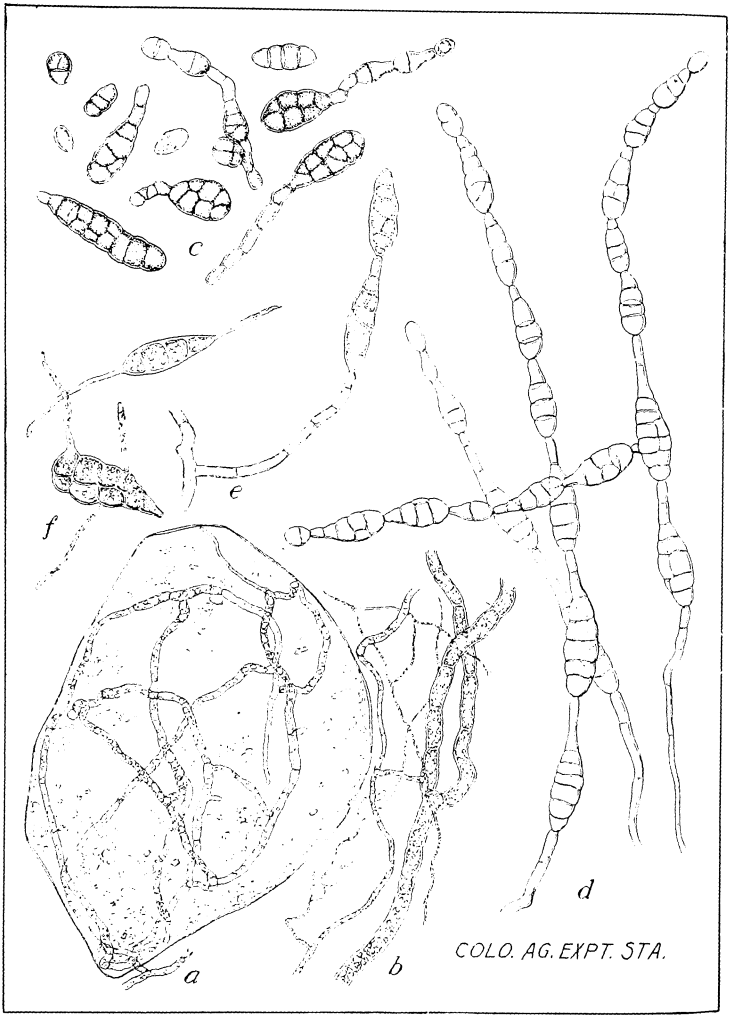


PLATE IV.—Microscopic characters of the *Alternaria*; (a) mycelial threads within a cell from rotting pear; (b) hyphæ showing the variable size of the mycelium; (c) mature spores from a culture; (d, e) manner of spore-formation from culture; (f) two spores germinating in water, at the end of three hours.

the case of the apple, that the fungus gains a foothold on the withered stamens and stigmas which remain in the blossom end of the fruit. This may quite often occur early in the season soon after the flowering period and while the fruit is just forming. For, when the withered stamens and stigmas are placed in a moist chamber, at this time, the *Alternaria* frequently develops. The rotting effects of the disease, however, do not usually appear until after the growing period is nearly past and when the ripening stage is reached. Thus it would appear that the fungus is not capable of making much headway while the tissues are in a young, growing condition and when the vital processes are most active, but behaves more in the nature of a ripe rot fungus and is, therefore, not strictly parasitic. This is also suggested from the fact that young growing apples when inoculated with the fungus were not much affected by it.

The principal source of infection in spring appears to be the diseased fruits of last year, which remain in the orchard in a shriveled and blackened condition, either lying on the ground, or sometimes left clinging to the fruit spurs. Young fruit which has failed to develop fully, perhaps due to imperfect pollination, is frequently found to be permeated with this fungus, after having withered upon the tree. In such cases the fungous threads within the tissues of these mummified fruits are capable of producing a crop of spores when the conditions are favorable the following spring. Some of these old diseased parts, when placed in a moist chamber, gave rise to a vigorous growth of conidia-bearing threads, the spores of which started the rot when used in making inoculations. The fungus evidently hibernates also on the twigs and fruit spurs, as it was obtained from them during the winter season. Wounds in the fruit caused by the larvæ of the codling moth frequently give entrance to the *Alternaria*. (Plate III).

ARTIFICIAL CULTURES AND INOCULATIONS.

Numerous cultures of the fungus have been made in the laboratory, using several different culture media. From these, inoculations of sound, ripe fruit were performed by inserting the spores of the fungus into punctures made with a sterilized needle. Usually in two or three days the point inoculated begins to show a surrounding area of decaying tissue, which widens rather slowly but steadily until the entire fruit is involved. The only fruit besides the pear and apple that has been inoculated with this fungus is the tomato, but in such cases it made almost no progress. (Plate I).

VARIETIES AFFECTED AND EXTENT OF INJURY.

In the case of the apple the varieties reported as most commonly subject to the *Alternaria* rot are the Lawver, Loy, Mann,

Dominie, Jonathan and Ben Davis, while the Winesap appears to be most commonly affected in the seed cavity, as previously mentioned. Some of these varieties are among those which are reported as dropping their fruit badly in some seasons during June and July, but whether or no the fungus plays any part in this matter has not been determined.

Among pears, the Keiffer is the only variety which has thus far shown any liability to attack from this fungus, although in the cases observed other varieties were growing in the same orchard.

The extent of the injuries due to this *Alternaria* have not been estimated even approximately. It is apparently, however, not a destructive fungous disease, as compared with some which attack the apple and pear in more humid regions. It is doubtless capable of doing considerable damage, however, to the fruit of susceptible varieties, some of which have been reported as almost failing to bring their fruit to maturity.

CONTROLLING THE DISEASE.

In the absence of any experimental work in the control of the *Alternaria* rot the methods for combating the fungus are necessarily suggestive. Attempts to control the fungus in one orchard, by the use of Bordeaux mixture, indicate that it can be much reduced. Whenever this fungus becomes troublesome the following measures are suggested:

(a) Clean culture, thereby covering up in spring all diseased fruit that is left on the ground under the trees besides keeping the trees in a state of good health.

(b) The use of some fungicide as a spray, the first application being a strong copper sulphate solution, one pound to twenty-five gallons of water, applied just before the buds open in spring. The standard Bordeaux mixture should be used after blossoming, making one or more applications during the growing season as may appear necessary. This may be used in conjunction with the poison mixtures applied for the control of the codling moth, thus saving extra labor and time.

(c) While it is very improbable that the disease will ever prove uncontrollable by the preceding means, should that occur, it would be advisable to discontinue the growing of varieties, which are particularly susceptible to the attacks of this fungus.