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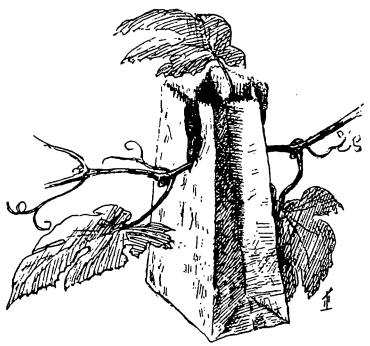

GRAPE POLLEN AND POLLINATION.

F. H. HALL, S. A. BEACH AND N. O. BOOTH.

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POPULAR EDITION*

OF

BULLETINS NOS. 223 AND 224.

GRAPE POLLEN AND POLLINATION.

F. H. HALL.

IS THE POLLEN OF SELF-STERILE GRAPES POTENT?

Many grapes self-sterile.

Investigations made at this Station during several years have proven clearly that many varieties of grapes fail to set fruit unless they receive pollen from other varieties. Consequent upon this discovery it was necessary, from both a scientific and a practical standpoint, to learn whether the pollen of these self-sterile varieties was itself wholly deficient in fertilizing power, or whether it was merely incapable of fertilizing pistils of its own variety or other similar self-sterile varieties; and, if possible, to ascertain the cause of self sterility.

Self-sterile varieties do not cross.

Tests made in 1899 proved that the pollen from self-sterile varieties could not fertilize other self-sterile kinds. Clusters of these self-sterile varieties were enclosed, before blossoming, in paper bags, to prevent accidental access of other pollen. At blossoming these clusters were subjected to the action of pollen from clusters cut from other self-sterile varieties and introduced into the bags. In nearly every case such clusters failed

* This is a brief review of Bulletins Nos. 223 and 224 of this Station, on Investigations Concerning the Self-Fertility of the Grape, by S. A. Beach and N. O. Booth. Anyone interested in the detailed account of the investigations will be furnished, on application, with the complete bulletins. The names of those who so request will be placed on the Station mailing list to receive future bulletins, popular edition or complete edition as desired. Bulletins are issued at irregular intervals as investigations are completed, not monthly.

to set any fruit. When the clusters introduced were from self-fertile varieties, however, the enclosed clusters ripened good bunches of grapes.

Impotent pollen.

In experiments made in the seasons of 1900, 1901 and 1902, it was also found that the pollen of these self-sterile varieties was practically powerless to fertilize the pistils of self-fertile varieties. To test this question an additional manipulation must be introduced into the bagging process, to get rid of the pollen of the self-fertile clusters. This was done by opening each flower of the self-fertile cluster selected and removing the anthers which contained the pollen. Great care was used in this operation to perform it at a time when the flower was sufficiently advanced so that removal of the tiny flower-cap would not interfere with proper development of the pistils, yet not far enough along so that any ripe pollen should escape to fertilize the pistil. The castrated clusters were immediately enclosed in paper bags as usual; and 86 clusters, on 9 varieties, were left undisturbed, as checks on this method of castration. These check clusters set only 42 fruits in all, about 1 per ct. of the total number of blossoms, thus giving a factor to be used in indicating the possible error for other clusters used in cross pollination. For the crossing test, five strongly self-fertile varieties were used,—Concord, Delaware, Diamond, Niagara and Worden,—and castrated bunches of these varieties were subjected to the action of pollen from the self-sterile varieties Black Eagle, Brighton, Eldorado, Herbert, Lindley, Merrimack and Salem. In most cases, no fruit whatever set.

In a few instances, however, there was a slight setting of fruit, hardly to be accounted for by defects in method of castration, delayed castration or other errors, which may indicate a slight power on the part of some of the varieties to fertilize other varieties even though the pollen be wholly impotent on its own pistils.

This appeared to be shown more clearly in other experiments, where a few castrated clusters, handled very carefully to prevent accidental pollination before or during castration, were subjected to the action of a large quantity of self-sterile pollen. In these

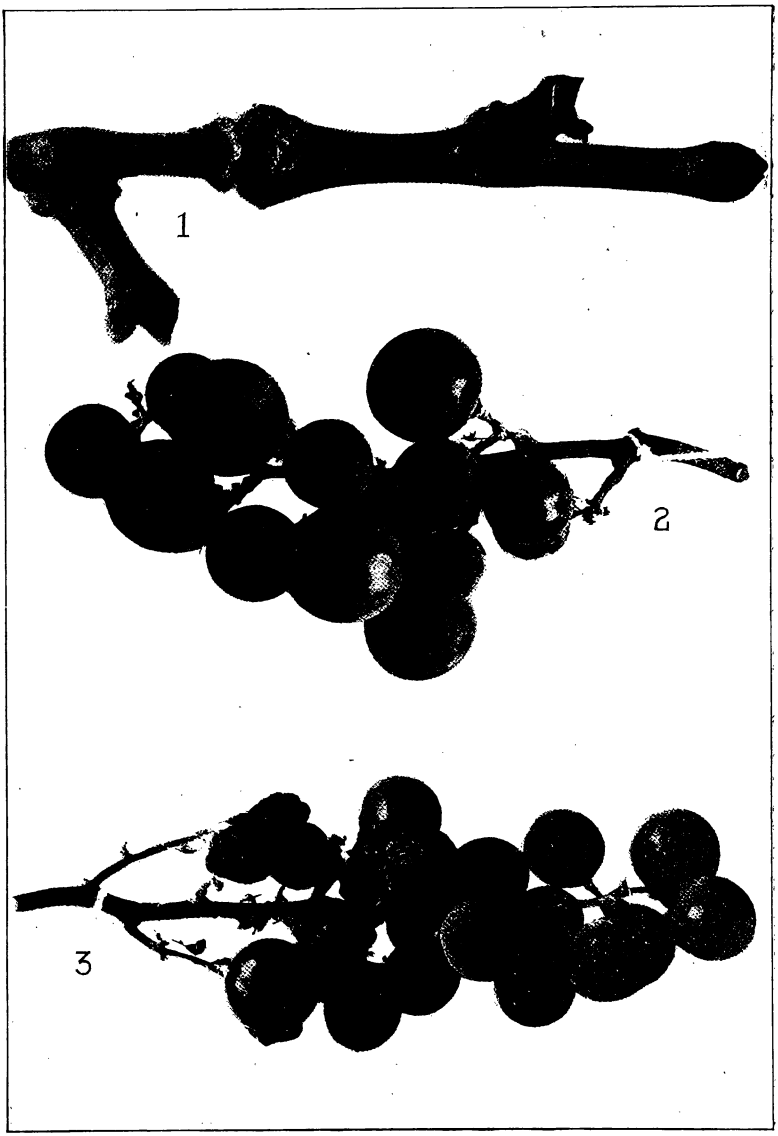

PLATE I.—EFFECT OF GIRDLING ON CANE AND FRUIT.

FIG. 1. FAILURE OF GIRDLE TO HEAL: AN EXTREME CASE.

FIGS. 2 and 3. BRIGHTON CLUSTERS ON GIRDLED CANES; EACH CLUSTER CROSS-POLLINATED WITH POLLEN FROM ANOTHER CLUSTER ON SAME CANE. BRIGHTON, SELF-POLLINATED, RARELY SETS FRUIT.

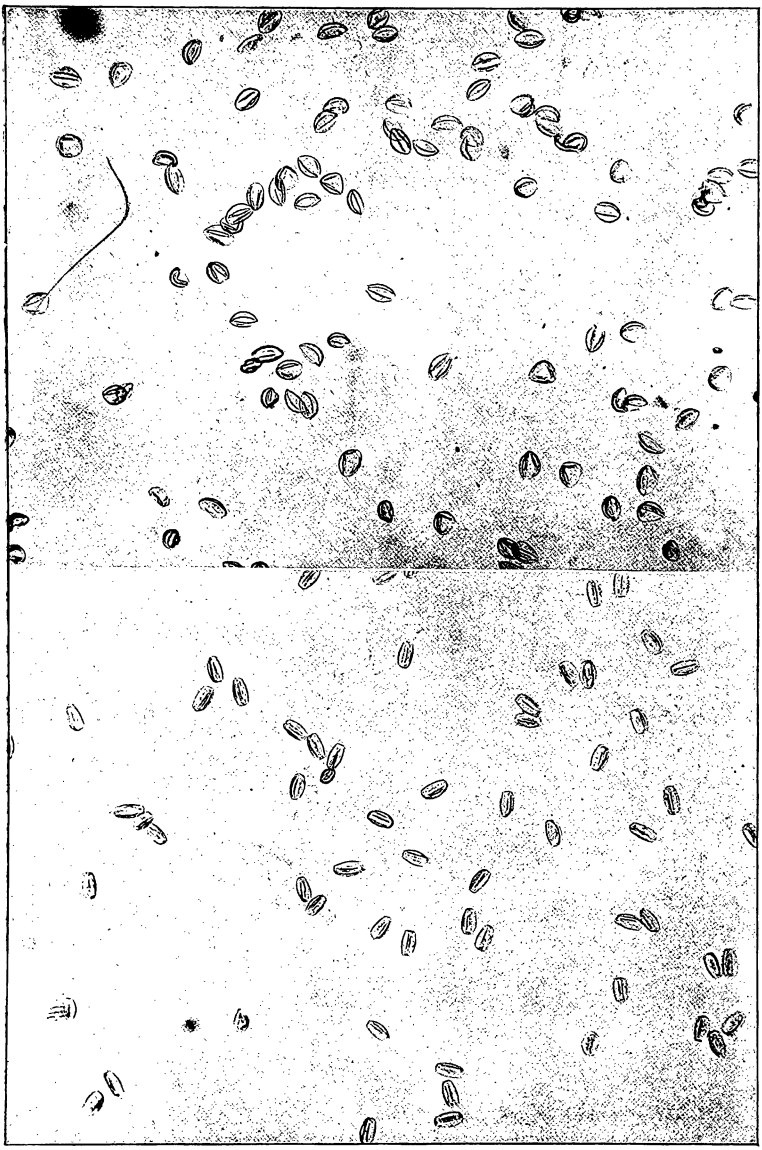

PLATE II.—GRAPE POLLEN:

UPPER.—BLACK EAGLE, SELF-STERILE.

LOWER.—TRIUMPH, SELF-FERTILE.

cases enough fruit set to indicate that the pollen of some of these self-sterile varieties finds other pistils slightly more congenial than those of its own variety.

Effect of Girdling on Self-Sterility.

Girdling influences fruiting. It is well known that girdling, by its interference with the course of sap circulation, may induce greater or more rapid development of fruit above the girdle. It was also observed, in some earlier tests, that canes on some self-sterile varieties of grapes which had been bent so as to obstruct the flow of sap appeared to set more fruit than undisturbed canes. Hence it was thought well to test girdling or bending the cane sharply to see if the additional supply of sap would not give more vitality to the pollen of self-sterile varieties and make them more or less self-fertile.

Method. Two systems of treatment were used. In one, a ring of bark $\frac{1}{8}''$ to $\frac{1}{4}''$ in width was removed between the first and second nodes of the selected fruiting canes about three weeks before the blossoms opened. At the same time other fruiting canes were either twisted at about one-fourth their length by winding them about the supporting wire as tightly as possible without breaking, or were bent sharply at about one-fourth their length and made to return upon the next wire.

At a suitable time some of the clusters on these canes which were to be tested for self-fertility were bagged, and later pollinated by the use of clusters from bent or girdled vines of the same variety. Others were left to the influence of their own pollen.

The girdle in this operation was made so narrow that it soon healed over in most cases, the check to the sap being only temporary.

Results. With Hercules and with those Vergennes clusters on a bent cane which were left open to cross-pollination it appears that the treatment stimulated to greater productiveness. Some evidence of such stimulation is also found in the cases of Brighton and Eldorado. Sample clusters of the former are shown in Figs. 2 and 3, Plate I. The treatment of the self-sterile Herbert and Salem failed to cause them to fruit.

The self-fertile varieties Concord, Delaware, Empire State and Niagara have generally a higher average rating on girdled than on untreated canes, but the advantage of the treatment, if any, is not striking.

If the girdling can be used on such nearly self-sterile varieties as Brighton and Eldorado, or such imperfectly self-fertile kinds as Vergennes, when these varieties stand in proximity to strongly self-fertile kinds and are exposed to cross-pollination from them throughout the blooming season, it may be that their productiveness may be thus profitably increased. Further investigations should be made on this point, as well as a comparative study of early and late girdling.

A Study of Grape Pollen.

Causes of self-sterility. As possible causes of this failure of grapes to set fruit, four reasons for self-sterility may be considered. (1) Pollen may fail to ripen at the same time as do the pistils in the same flower or on the same plant. This can hardly be the case with the grape, since some pollen is shed as soon as the pistils are ready for fertilization and it continues to fall for some time and retains its vitality for a long period. Grape pollen was germinated at the Station three weeks after it had been gathered in California. The arrangement of the flowers of the grape in clusters and the continuous opening of these flowers also aids in providing pollen to fertilize all pistils. (2) There may be a lack of affinity between the pistils and pollen of the same flower or plant, so that no fertilization takes place, although viable pollen falls upon the pistils. There is a suggestion of this in the experiments just noted, as there seemed, in some instances, to be better fertilization by self-sterile pollen on pistils of self-fertile varieties; but this can account for only a small part of the lack of fertility, since only a very small percentage of pollen from a limited number of self-sterile varieties caused fruit to set in cross pollination tests.

(3) The pollen may be so scanty as to render fertilization improbable if not impossible. This factor was studied with some care at the Station as it was thought one of the probable causes. Observations were made both with naked eye and with the micro-

scope. Striking variations were found in the amount of pollen present on the different blossoms but the variations were not significant since they were often greater between different clusters on the same vine than between clusters on different vines of different varieties. With most of the self-sterile varieties observed the pollen was quite plentiful and apparently sufficient for pollinating purposes.

(4) The pollen itself may be defective or without viability. Several lines of investigation prove this to be the most probable cause of the trouble.

Germination of pollen.

These tests were made in the laboratory with culture chamber and microscope; but they shed a light on the problem impossible to get through the most careful field work.

Pollen was secured from 22 different varieties, half nearly or quite self-sterile, half perfectly self-fertile or nearly so, compared varieties being taken from *Riparia*, *Labrusca* and *Lincecumii* types. This pollen was germinated in small culture chambers in solutions of sugar or dextrose of various strengths, the percentage of the grains germinating and the character of the growth being carefully noted in microscopic examinations. Of 14 varieties grown in 20 per ct. sugar solution, which seemed well adapted for growth of grape pollen, only two self-sterile varieties showed any germination whatever, one giving 1 per ct. and the other 5 per ct.; while each of the self-fertile varieties gave considerable growth, the percentages of germinated grains varying from 5 per ct. to 95 per ct. and averaging over 40 per ct.

Physical differences.

These results indicate that a very large percentage, if not all, of the pollen grains of self-sterile varieties are inherently defective, and microscopic examination shows striking differences between pollen of this character and that from self-fertile varieties. The self-fertile grains seem to be surrounded by a mucilaginous substance which makes them stick together and lie in groups or clumps on the microscope slide. The self-sterile grains lack this mucilaginous covering and distribute themselves on the slide like so much dry powder, quite by chance.

But still more noticeably, the two classes of grains show a decidedly different form. The self-fertile forms are oblong oval, blunt at the ends and quite symmetrical, while the self-sterile grains are irregular and even when they approach the shape of perfect pollen they are usually more pointed. This difference is plainly shown on Plate II.

Varieties of grapes which are in classes intermediate between self-sterile and self-fertile were found to have pollen grains of both forms. In testing the germination of such pollen the percentage of grains showing development was quite close to the percentage of forms of the perfect type. "These results seem to confirm those previously secured in the field, in showing that one of the reasons why certain varieties of grapes are self-sterile is a lack of viability or potency in the pollen itself." The physical differences are important from a practical standpoint; since examination of the pollen of a new or untested variety at blossoming time will determine quite accurately its self-fertility or self-sterility without the delay, difficulty and possible errors involved in bagging tests. They may be helpful also in selection of varieties to be used as fertilizers. They may also at times be useful in distinguishing varieties before fruiting; since varieties of similar parentage may resemble each other closely, yet one be self-fertile, the other self-sterile as is the case with Lucile and Wyoming.