THE COVER CROP AT PICKING TIME

SOME NEW APPLES FROM KNOWN PARENTS

SUMMARIZED BY
F. H. HALL
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The apple must be called America's leading fruit, yet almost no careful breeding of it has hitherto been done. Of 698 varieties described in "The Apples of New York," both male and female parent are certainly known for only one variety; one parent is known and the other guessed, for two other kinds; four are held to be sports from known varieties; and the female, or seed-producing, parent, is given for 39 kinds. Of the remaining 650 varieties, 71 are said to be seedlings (of unknown parentage); but, for the great majority of the kinds nothing is positively known as to the origin. This poor showing for scientific, commercial or careful amateur apple breeding is due to several causes: Breeding tree fruits of any kind is time-consuming and space-demanding; the pecuniary rewards for individuals are inconsiderable or altogether wanting; institutions organized to do plant breeding have felt obliged to work in other fields where results could be more quickly secured and would mean more when obtained; and lastly, plant breeding, especially breeding of tree fruits, has until recently seemed largely a matter of guesswork and chance—a process most of whose fundamental laws were unknown.

*This is a brief review of Bulletin No. 350 of this Station, on An Experiment in Breeding Apples, by U. P. Hedrick and Richard Wellington. Any one interested in the detailed account of the investigations will be furnished, on application, with a copy of the complete bulletin. The names of those who so request will be placed on the mailing list to receive future bulletins of the Station, popular or complete as desired. Bulletins are issued at irregular intervals, as investigations are completed, not monthly.
But within the past ten years plant breeding has made rapid advances, owing to the discovery, after it had lain hidden for half a century, of work which established some very elementary laws of heredity. These laws make it possible to work with plants, and, to quite an extent, with animals with a certainty of securing the desired results with much less effort and time than in former years.

This old work of Johann Mendel established the fact that some of the characters, of both plants and animals, are inherited unchanged, passing down through each subsequent generation. Many of them may be hidden in the first generation of progeny and in a fraction of the descendants of each subsequent generation by the "dominance" of stronger, opposed, or differing, characteristics of the same group. But both the "dominant" and the "recessive" (weaker or hidden) character of a Mendelian pair reappear in pure form in part of each generation after the first; so that the descendants of two parents, both showing the same one of these pure characters, will always be like their parents in respect to this character.

Now, the problem of the breeder is to ascertain what characters follow this law — for not all do — and to secure the ones desired in pure form and in suitable combinations. When once secured as desired in two parents, the descendants may be depended on to show the same characters and not to "revert" to some form not wanted. But, even simplified as it is, the problem is still very complex; for the features or characteristics we think of as separating one plant or animal from another may each be made up of two or more heritable characters; and the possible combinations, in any individual, of these varied "unit characters" are exceedingly numerous and varied. All these variations must be secured and checked by growing multitudes of seedlings, of at least two generations, before we can be positive of our ground on more than a few characters.
For this reason, much careful work must be done with any of the species or varieties man uses or desires to use, in breeding. With the apple, as already indicated, so little breeding work has been done that we know almost nothing of the inheritance of characters; therefore the information secured from work at this Station in making crosses between eleven varieties of apples is published at this time, though admittedly incomplete.

These breeding experiments were begun before Mendel’s laws of breeding were familiar to more than a few scientists, and were not made with any purpose of testing those laws. Since we know so little of the origin of the varieties used we are handicapped at the start in interpreting the results by the new laws; as we can not tell whether we are working with pure characters, separated out by running through two or more generations, with dominant characters showing in the first cross and hiding their recessives of the Mendelian pairs, or with “blended” characters. It is very probable, however, that, with regard to many characters, the apple varieties of to-day are themselves crosses; so that when we again cross these varieties, some characters split up into pure dominants and recessives and give us a clue to the transmissibility of the parental characteristics. The only way this can be proved, though, is by growing large numbers of seedlings from self-fertilized seeds of both parent and descendant varieties—a matter of great difficulty in the apple, which does not readily self-fertilize and, when it does, appears to give seedlings of inferior vigor. Work along this line will give results of scientific value and should, logically, precede presentation of data or conclusions regarding the inheritance of characters. Such work is in progress at the Station, hindered by the apple’s opposition to self-pollination; but as it must be at least ten or twelve years before trees of the second generation are in bearing it seems best to give, now, the practical results of the apple crosses made, under Prof. S. A. Beach’s supervision, in 1898 and 1899.
During these two seasons 148 crosses were made from which the following seedlings have fruited, first from grafted wood and later from the seedling trees: From Ben Davis x Esopus 4; from Ben Davis x Green Newtown 13, from Ben Davis x Jonathan 11, from Ben Davis x McIntosh 11, Ben Davis x Mother 20, from Esopus x Ben Davis 29, Esopus x Jonathan 2, McIntosh x Lawver 1, Ralls x Northern Spy 9, Rome x Northern Spy 1, and Sutton x Northern Spy 5. These seedlings show marked vigor and are noticeably healthier and more productive than others from self-pollinated seeds, either of Hubbardston or Baldwin, of which considerable numbers are growing at the Station, comparable in age to the crossed seedlings.

Contrary to the usual belief, these seedlings have not "reverted to the wild;" but show to a marked degree the characteristics of the parents. So evident is the inheritance of parental characters that one familiar with the varieties crossed could in most cases select the parents for individual seedlings. Indeed, so surprisingly uniform has been the transmission of the good qualities of the selected varieties that the fruit of 14 of the 106 fruiting seedlings is considered as good or better than either of the parents, and the trees are satisfactorily productive. These seedlings have been named, from counties in New York State, and are already distributed to some extent among apple growers.

These varieties are, with the briefest possible description of each, the following:

**Clinton.** *(Ben Davis x Green Newtown).* — An attractive midwinter apple of medium size, resembling Green Newtown in shape and quality, but of a handsome red color.

**Cortland.** *(Ben Davis x McIntosh).* — A large apple of the McIntosh type, in season from November to February, and promising commercially.

**Herkimer.** *(Ben Davis x Green Newtown).* — A fruit for late
winter, of good quality and handsome appearance. It resembles Ben Davis externally and internally but is much better in quality.

**Nassau.** (*Esopus x Ben Davis*).—A medium-sized apple of attractively contrasting red and yellow color, much better in quality than Ben Davis but hardly equal to Esopus. Its season is late fall.

**Onondaga.** (*Ben Davis x McIntosh*).—A medium-sized, mid-winter apple, of very handsome greenish-red color almost entirely overspread with dark McIntosh red splashed and mottled with carmine. It is of the McIntosh type, but more conical in shape, desirable for cooking and would be liked by many as a dessert apple.

**Oswego.** (*Sutton x Northern Spy*).—Larger than Northern Spy, more conical, brighter in color and equal in quality though of a different flavor. It is a late winter and spring variety.

**Otsego.** (*Ben Davis x McIntosh*).—Though rather small, this apple was thought worthy of propagation because of its handsome, bright red color, good quality, small core and few seeds. It is in season in early winter.

**Rensselaer.** (*Ben Davis x Jonathan*).—Of Jonathan type, exceedingly attractive in color and of fine flavor, though of only medium size. Its season extends through the winter months.

**Rockland.** (*Ben Davis x Mother*).—This cross resembles Mother in size, shape, color, texture, flavor and quality and should be especially desirable as a dessert fruit in early and midwinter. It is most pleasing in appearance, though small.

**Saratoga.** (*Ben Davis x Green Newtown*).—A large, late winter and spring apple, nearly or quite as good as Green Newtown. The bright, purplish red color is spread over greenish yellow and is splashed and mottled with crimson, making it very bright and attractive.

**Schenectady.** (*Ben Davis x Mother*).—A remarkably handsome early winter variety, red in color with carmine mottles and splashes and brightened by greenish yellow undercolor. It is
large in size and of fine roundish conic shape. While not quite high enough in quality for a dessert apple it is much better than Ben Davis.

Schoharie.  (*Ralls x Northern Spy*).—Of Northern Spy type, good size but not large. It has the delicious flavor and aroma of the Spy but its flesh is more yellow. It is in season in late winter and spring and is desirable for either cooking or dessert, but is a trifle dull in color.

Tioga.  (*Sutton x Northern Spy*).—Another most promising, late winter and spring apple of Northern Spy shape, of high quality and handsome appearance. It is large in size, yellow in color, blushed, mottled and faintly splashed with pinkish red.

Westchester.  (*Ben Davis x Green Newtown*).—Of Green Newtown shape, but even better in quality and with the attractive Ben Davis color. It is a medium-sized, early winter, dessert apple.

Beside these varieties definitely selected for naming and propagation, as many others have been retained for further testing as promising. This is a remarkably good showing for seedlings of any kind and would seem to promise satisfactory returns for the time, space and expense involved in future apple breeding.

New varieties almost wholly from crosses.

It is by crossing like that in these experiments that we must hope to secure valuable new varieties of apples. There is little or no evidence to show that this fruit can be improved by selection within the variety; we have no record that any good apple has come from self-pollinated seeds; and the number of useful sports is small and conditions under which these originate as yet wholly unknown. Chance seedlings may, of course, give good varieties; and it is probable that most of our cultivated apples have come from such accidental crossing; but if as good results as were secured in the experiments here discussed can be counted on to follow the crossing of selected parents it is a waste of time and energy to grow the multitude of seedlings
necessary for selection from natural crossing. The technic of artificial crossing is simple, involving merely the selection and bagging of unopened flowers on the male and female parents, removal of stamens from the female flower before pollen has matured and the introduction of pollen from the protected male flower when the stigma of the female flower is receptive. Shortly after the fruits have set the paper bags are removed and sacks of mosquito netting substituted.

When we know more of the inheritance of apple characters in general it should be a comparatively easy matter to select parents that carry the ones we desire and to unite them in combinations superior or at least different from any we now have. We can not in this way, however, expect to secure new characters. Such deviations, if they ever arise, must come from sports, or from crosses outside the range of cultivated varieties.

How qualities inherit. As indicated before, it is not safe to make generalizations from the progeny of a first cross, as first generation crosses inherit the characteristics of both parents unseparated, it being only in the second and subsequent generations that the Mendelian pairs segregate (that is, separate in pure, inheritable form in part of the seedlings); but the chances are great that in any crossing of apple varieties to-day we are really combining crosses, so that some pairs of characters are split up in what is really the second generation so far as these characters are concerned. That is, if we cross two red varieties, and secure some yellow seedlings, it is very good evidence that one or more of the unknown ancestors of the parent varieties must have been yellow-fruited and that the yellow seedlings are pure for that character.

Even if this be not true it still seems worth while to indicate what seem to be the heritable characters of the parents in these experiments; for any variety obtained in this way is continued by grafts or buds (parts of the original plant) and so remains con-
stant, being subject to none of the fluctuations that arise in continuing a variety from seed.

Also, if certain characters of a parent variety reappear with considerable constancy in a considerable number of seedlings of that variety, especially if the cross is made with two or more other varieties, it is fair to assume that these characters will also appear when other crosses are made, even though we can not say that the character is a pure dominant or recessive. This would be true, in particular, if any variety were prepotent in regard to some of its characters, as appears to be the case with Ben Davis in these crosses; that is, many of the Ben Davis characters are apparently dominant characters of Mendelian pairs, so that they appear in the first generation crosses, no matter what the characters of the other parent may be.

Among the best of the eleven varieties used in this breeding work, so far as production of desirable new kinds is concerned, are Northern Spy, with three named varieties and four promising ones out of 15 seedlings; McIntosh with two good and four promising seedlings out of 12, and Ben Davis, with every eighth seedling worthy of naming and nearly as many more of enough merit to be retained for further testing. Green Newtown was crossed only with Ben Davis, but seems a very desirable parent, as four seedlings out of thirteen, or more than 30 per ct. of those grown, received names as desirable new varieties.

Northern Spy gave large-fruited seedlings in most cases, some of them larger than either parent; but in the cross with Ralls, a fruit of moderate size, small fruited descendants appeared in such proportions that it is probable that some ancestor of the Spy as well as of Ralls must have borne small fruit. The Spy also impressed its own shape when crossed with Sutton, but not when crossed with Ralls. It gave some yellow-fruited seedlings when
crossed with Sutton, but in other crosses gave only reds of more or less intense shade. No sweet apples appeared among the Spy seedlings.

McIntosh, though a sub-acid variety and crossed with two other sub-acid kinds, gave two sweet seedlings. Most of its progeny were red, but four of them were yellow proving McIntosh a bearer of that color in spite of its dark red skin. The pure white of its flesh is evidently a weak character as it was hidden in most cases by the yellower flesh of the other varieties of the crosses.

Ben Davis carries sweetness as a recessive character, since some of its descendants were sweet in each of the crosses where several seedlings were obtained. It did not notably impress its shape when crossed with Jonathan or Green Newtown; but did so about equally with the other varieties with which it was bred. In size, most of its descendants are intermediate between the parents, but with Green Newtown some of the seedling fruits are larger than either parent and none smaller. In color, all the Ben Davis seedlings are red unless the yellow could come from the other parent.

Green Newtown appears prepotent in transmitting its shape, the obliqueness of this parent appearing in nearly all the offspring; and all are equal or superior in size to either parent. Nearly one-fourth of the Green Newtown seedlings are sweet, and five out of the thirteen showed yellow color.

Jonathan carries red color only, and gives its shape to most of its progeny; Mother probably transmits red only, and gave eight sweet apples among its twenty descendants; and Ralls probably carries only red and a strong shape-determining factor.

Regarding other varieties the data are too limited to justify specific statements.

Summary. The large percentage of good or promising new varieties obtained in this work, appears to promise favorable results in further apple breeding; but the difficulties in the way must not be forgotten.
We know, as yet, almost nothing of the unit characters in apples, and the way they are inherited, and until this foundation knowledge is secured it will be difficult to select, with any degree of certainty, the parents whose progeny will combine the qualities we desire in our new variety.

The determination of the factors by which the various characters are transmitted will be no easy task; for work in other fields proves that many characters depend not on one factor alone, but on several that may be separately inherited, and the experiments here recorded indicate that this is markedly true of the apple. Shape, size and color of fruit may depend upon the presence or absence of several factors. Some factors or characters may not appear at all in the first generation, and this skipping of a generation may complicate matters and involve a second crossing and wait of ten or twelve years before we secure the combination the parent characters led us to expect. To secure all the possible combinations from any cross we must have large numbers of plants, which is difficult and time-taking with apples.

There is liability also, in selecting parents, of mistaking qualities due to environment rather than to the constitution of the plants themselves; for these qualities, as acquired characters, are not inherited; though the advocates of "pedigreed stock" would lead us to suppose that they are.

In some cases, also, characters do not act as Mendelian pairs; but blend rather than segregate in crossing, so that the seedlings may, in some desired respect, be intermediate between the parents, giving no combination containing the one specially good quality we wish.

These and other difficulties confront the apple breeder; but the importance of the fruit, and the help we have in Mendel's laws, making breeding a problem and not a riddle, certainly justifies much careful, continuous work with this queen of American fruits.