

was the only determining factor of the relative adaptability to the utilization of the less available forms of plant food, this variety should also be intermediate in such adaptability, but as a matter of fact we find it the least adapted of the three varieties. In this respect it differs from most of our hybrids for nearly all of them do relatively better when grown in rotation with other crops.

From the selection made in 1909 we seem to have developed in hybrid 157 a very high yielding variety which is even better adapted to continuous culture than Zimmer Spanish which among the older varieties stands preëminent in this respect. In appearance the tobacco closely resembles Zimmer Spanish and if the quality proves good should be a valuable sort for the grower having but a few acres of ground, the greater part of which he feels must be planted in tobacco every year.

APPLE BREEDING IN CANADA

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Apple breeding in Canada has not had a very long history, nor have there been many men engaged in it, but there have been a few enthusiastic workers who have done something in that country towards the improvement of the apple. The late Charles Arnold, of Paris, Ont., was probably the first man in Canada to breed apples by crossing. In 1873 he exhibited at the meeting of the American Pomological Society at Boston, Mass., eighteen varieties of cross-bred apples, all of which were seedlings of the Northern Spy crossed with Wagener. The only one of these which has become a commercial apple is the Ontario, well known in the province after which it was named. This apple has the size of the Northern Spy and the early bearing qualities of the Wagener. It is oblate, like Wagener, but resembles Northern Spy very much in color, though it has more bloom. The quality is good, but the flesh is somewhat tender for long-distance shipment. It is a winter apple. The Ontario apple received a special prize in 1874 from the Ontario Fruit Growers' Association.

One of the early workers in apple breeding in Canada was the late Francis Peabody Sharp, of Upper Woodstock, N. B.—born in 1823; died 1903. He began cross-breeding about the year 1869 and is said to have made a thousand crosses with the object of producing an apple which should have extreme hardiness and productiveness. He used to a large extent the so-called "New Brunswicker" apple for

the mother and the Fameuse for the male parent. An apple resulting from the crossing with the above parents which has obtained more than local prominence is the Crimson Beauty, at first called Early Scarlet, a handsome summer variety of medium quality which is being grown to a considerable extent in New Brunswick and other provinces in Canada. This apple began to be propagated in a large way in New Brunswick in 1887. Unfortunately Mr. Sharp did not leave a record of the parentage of many of his crosses. Some of the most promising of his crosses which have come under our observation are the following "Bittersweet," an autumn apple of good quality and said to be one of Mr. Sharp's earliest crosses between New Brunswicker and St. Lawrence. "Munro Sweet" (Sharp's), a sweet apple of good quality, with a season from early to mid-winter; said to be a cross made between New Brunswicker and an unknown apple about 1869 and fruiting first in 1879. "Woodstock Bloom," a winter apple, is another cross between "New Brunswicker" and Alexander, which has proved hardy in New Brunswick. The "New Brunswick" apple which so closely resembles the Oldenburg that most pomologists have not been able to distinguish one from another, is said to have originated with Mr. Sharp, and as this apple—whether it be Oldenburg or whether it be another variety—has been of very great value to New Brunswick on account of its hardiness and productiveness, the history of it given by Mr. Sharp and the Sharp family should be recorded in a paper on Apple Breeding in Canada. The apple is said to have originated in 1851. Mr. Francis Peabody Sharp obtained seeds from a nurseryman in Bangor, Maine, named Dunning. These were planted in his nursery at Woodstock. Some of the seedlings stood until the third year. In that year a Darius Shaw, who was working for Mr. Sharp, saw a vigorous looking tree in the nursery with several fine apples on it and brought Mr. Sharp's attention to it. This is the tree which was afterwards called the New Brunswicker.

The late Peter C. Dempsey, Albury, Ont., did considerable plant breeding and used the apple to some extent in his work. The only varieties used as parents of which we have been able to find a record are the Golden Russet and Northern Spy. He crossed these, and among the seedlings he obtained from this work two were named and are being grown today. These are the Trenton, a red September apple which is highly regarded near where it originated, and the Walter apple, a large, striped, October apple of good quality, not unlike Gravenstein in appearance, flesh and flavor.

Dr. Wm. Saunders, late Director of the Dominion Experimental

Farms, began the cross-breeding of apples in 1894, with the main purpose of originating varieties which would prove hardy in the prairie provinces of Canada.

In Bulletin No. 68, Progress in the Breeding of Hardy Apples for the Canadian Northwest, of the Dominion Experimental Farm Series, published in 1911, Mr. Saunders, before his retirement from the government service, gives a history of his work in breeding apples and the results which were obtained.

In his first crosses Dr. Saunders used as the female parent the *Pyrus baccata*, or Berried Crab. The tree on which most of the crosses were made was grown from seed obtained from the Imperial Botanic Gardens, St. Petersburg, Russia, in 1887. From the same lot of seed, trees had been sent to the Experimental Farm at Brandon, Man., and Indian Head, Sask., and as they had proved hardy there and produced fruit it was thought that this crab would be good material out of which might be developed hardy apples of marketable size for the prairie provinces of Canada, as up to that time, and even up to the present time, except in southern Manitoba, the successful culture of apples is very uncertain there; although we believe that in the wooded districts in Manitoba, Saskatchewan, and Alberta, where the soil is light and well drained, with proper methods of culture the hardiest apples of good marketable size could be grown successfully. The development of Dr. Saunders' work in cross-breeding has been well described by him in his bulletin, as follows:

After four or five years' experience had thoroughly established the character of the berried crab for extreme hardiness, efforts were made to improve the size and quality of the fruit by cross-fertilizing the flowers of *Pyrus baccata* with pollen from many of the hardiest and best sorts of apples grown in Ontario. This work was begun in 1894, and has since been continued along several different lines. The seeds obtained from the first crosses were sown in the autumn of that year and germinated in the following spring, producing, in all; about 160 young trees. These were planted in the spring of 1896, when many grew rapidly and soon made shapely specimens. These, and other young trees, resulting from similar subsequent experiments, have been planted from year to year in orchards at Ottawa, Brandon, Indian Head, and other northwestern stations. In 1899, thirty-six of the cross-bred apples first produced and grown at Ottawa fruited, and five of them were of such size and quality as to justify their being propagated for more general test. The fact that so many of these fruited in the fourth year from the sowing of the seed indicates a very early fruit-bearing habit. Since then several hundred more of these cross-bred apples have borne fruit, and the number of varieties worthy of extended cultivation has been considerably increased. Root-grafts of some of the more promising sorts were early made and these have been tested for eight or ten

years past at each of the northwestern farms and have shown very slight inclination towards tenderness, even when planted in exposed situations. The cross-bred sorts grafted on roots of seedlings of *Pyrus baccata* have produced trees which, so far as they have been tried, seem to be quite as hardy as the wild form of *baccata*. There seems every reason to expect that they will prove generally hardy throughout the northwestern country.

Experiments with Pyrus prunifolia and Pyrus malus.—In 1896 a series of crosses was begun on another sort of wild crab, known as *Pyrus prunifolia*. This is regarded by some botanists as a distinct species; others believe it to be a hybrid between *P. malus*, the wild crab of Europe, and *P. baccata*. Seeds of this form were also obtained from the Royal Botanic Gardens, St. Petersburg, Russia. The fruit of *P. prunifolia* is usually larger than that of *baccata*, and will average nearly twice the size. Its hardiness in the Northwest has also been established by a test covering a number of years on both of the experimental farms at Brandon and Indian Head. The first crosses with this species were made in 1896, and since then many new sorts have thus been originated.

Another line of work in producing new apples was begun in 1902, in crossing *Pyrus malus*, the wild apple of Europe, with some of the best Canadian sorts. This fruit is about an inch in diameter to start with, and of fair quality. A hardy form of this tree has been secured which has stood several winters at Brandon and Indian Head without injury, and with this additional crosses have been made.

Many of the best of the crosses produced on *P. baccata* and *P. prunifolia* have been recrossed, thus introducing a second quota of the blood of the larger apple with the hope of obtaining fruits of larger size and better quality. Regarding these there is as yet not much proof that they are sufficiently hardy to endure the climate of the Northwest; this can only be fully determined by further experiment. Two varieties of these crosses of Ontario and Spy have been tested for several years at Indian Head, but have not yet fruited. Thus far they have been fairly hardy. The first one-year-old trees produced by this method were planted in the orchard at Ottawa in the spring of 1904

Apples from which pollen has been used.—In the first crosses made on *Pyrus baccata*, in 1894, pollen was used from the Tetofsky, Duchess, and Wealthy apples, but since then pollen has been obtained from many other varieties and used on *P. baccata*, *P. prunifolia*, and *P. malus*, among them Anis, Beautiful Arcade, Broad Green, Excelsior, Fameuse, American Golden Russet, Haas, Herren, Krimskoe, McIntosh Red, McMahan White, Osimoe, Pewaukee, Red Astrachan, Ribston Pippin, Scott's Winter, Simbirsk No. 9, Swayzie Pomme Grise, Tolman Sweet, Winter St. Lawrence, and Yellow Transparent. The number and variety of the crosses have thus been very much increased. Many hundreds of these cross-bred varieties of *baccata* origin have been produced, and most of them have fruited. While a large number have proved of inferior quality, there have been originated, up to the present time, about sixteen varieties in all, most of which, from their superior size and quality, may be regarded as useful for domestic purposes and deserving more extended trial.

The best varieties resulting from these crosses were named and are described in Bulletin No. 68. The names are Alberta, Bow, Charles, Columbia, Elsa, Jewel, Kent, Mecca, Norman, Osman, Otto, Pioneer,

Prince, Robin, Romney, Silvia, Tony. These are the best out of about 800 trees.

The fruit of the *Pyrus baccata* used by Dr. Saunders as the female parent is about a half to three-quarters of an inch in diameter. The larger of the first generation of crosses are from one and one-quarter to one and three-quarters of an inch in diameter. The better ones have little or no astringency and compare very favorably in quality with the best named crab apples on the market. Nearly all of them retain the marked crab characteristics of long, slender stem; thin, tender skin; and crisp, breaking flesh. Some of them have proved distinctly hardier than others when tested in the prairie provinces. Some of the hardiest are Columbia, Osman, Jewel and Silvia, and it is interesting to note that the female parents in all these cases were hardy Russian varieties.

It will be noted that in these first crosses no reference is made by Dr. Saunders to any reciprocal crosses with *Pyrus baccata* as the male parent. We understand that few crosses were made with the crab as the male parent.

The best of these crosses were sent to about 200 locations in the Canadian Northwest representing altitudes ranging in elevation from 740 to 4200 feet. The first distribution was made in 1902. Dr. Saunders reports in his bulletin, "Reports have come in from many who received the trees, and in almost every instance they are reported as entirely hardy, having stood the winters to which they have been exposed without injury, and in some instances borne fruit." The furthest north that these crosses have fruited so far as we are aware is at Fort Vermilion, Peace River, in latitude 58°, the first fruit recorded being in 1910.

Many hundred seedlings of these first generation crosses have been raised, with the expectation that some of the seedlings would be even larger than the parent, but in practically every case the seedlings were smaller and many reverted to the size of *Pyrus baccata*.

In order to, if possible, obtain larger apples and still retain sufficient hardiness in the crosses to withstand the severe climate of the prairies, Dr. Saunders re-crossed the best of the first-generation crosses with some of the cultivated varieties of the apple. From these second crosses, which were made in 1904 and following years, there were this year 407 trees growing in the orchard at Ottawa. A number of these have now fruited, and while the majority bear little, if any, larger fruit than the female parent a few are considerably larger. Martin, which is a cross between Pioneer and Ontario, is $1\frac{1}{2}$ inches by $2\frac{1}{4}$

inches in size, and there are others not named which are about as large. Most of these crosses still retain the long, slender stems, the thin, tender skin, and the crisp, breaking flesh which are characteristic of this crab apple. The fruiting of the remainder of these crosses and the testing of the best of them in the colder parts of Canada to determine their hardiness is awaited with much interest. A few crosses were also made by Dr. Saunders between the named varieties of apples and between the Hyslop crab and the apple. Three apples resulting from this work which have been named are Rideau (Wealthy \times Oldenburg), Fairfield (Hyslop \times Oldenburg), Samson (Oldenburg \times Anis), which will be useful if they prove hardy in the prairie provinces. Dr. Saunders was assisted in his work by his son, Dr. Charles E. Saunders, who made a large number of the crosses.

In the year 1895 Mr. John Craig, then horticulturist of the Central Experimental Farm, Ottawa, did some crossing with the object of obtaining hardy, long-keeping apples, of which there is a great need in the colder parts of Ontario and Quebec. He crossed McMahan with Scott Winter, and Walbridge with Northern Spy. Of the former cross there were 37 trees, and of the latter 7 trees. A number of winter apples resulted from this first cross. Neither of the parents is of good quality and the crosses are lacking in this respect also, but as the trees appear very hardy and the apples are attractive in appearance some of them have been named. Four of the most promising are Granby, Walton, Sorel and Kelso. None of the crosses between Walbridge and Northern Spy have been considered good enough to name. The flesh of most them has been very firm. Work in raising apples from seed from naturally pollinized flowers was begun by Mr. Craig in 1890, when 3000 seedling apples trees were planted out at Ottawa. These were raised from seed imported from north of Riga, in Russia. The trees began fruiting in 1897. Most of the trees proved very hardy, but while the fruit of a large proportion of them was as good as many of the named Russian apples which were introduced into Canada, very few of them were considered superior. Rupert, Percival, Neville, Oscar, and Claire are five of the best of these.

In 1898 the writer, believing that in an orchard at the Central Experimental Farm, Ottawa, containing between 400 and 500 named varieties of apples all sorts of combinations of characters would be taking place by natural pollinization and that the chances of obtaining some good seedlings by sowing seeds from some of these varieties would be very great, had seed saved of some of the best-flavored apples then fruiting in the orchard, as well as some other varieties

desirable on account of other characteristics. There were included in these the McIntosh, St. Lawrence, Fameuse, Wealthy, Shiawassee, Swayzie, Scott Winter, Salome, Lawver, Gano, Northern Spy, Winter St. Lawrence, and Bullock (American Golden Russet). The seedlings of these and others which were sown later have been planted out at different times, beginning in 1901, until about 2000 trees were planted, this being all we had room for. The first tree to fruit from seed was a Wealthy seedling now called Crusoe, which fruited in 1903, two years after planting and five years from seed, and it may here be stated that the great majority of the Wealthy seedlings were early bearers like the female parent.

The good results which it was hoped to obtain by planting seedlings from fruit from trees which must have received pollen from a great many varieties has been abundantly borne out by the actual results. During the past eight years 997, or practically 1000, of these seedling varieties have fruited. Of 581 of these of which detailed descriptions had been made previous to this year, 78½ per cent were of marketable size, and only 5 per cent were small or crab-like. Of the 997 varieties, over 200 have been considered so promising that they are being propagated for further test and between 50 and 60 of the best have been named.

Some most interesting facts have been noted in regard to the way in which the seedlings resemble the female parent. If the parent is bright in color most of the seedlings are bright in color, but if dull in color then the seedlings are dull in color. If the parent is an apple of good quality then with few exceptions the seedlings are above medium to good in quality, and on the other hand if the parent is of inferior quality the seedlings are of medium quality also. If the parent is a long keeping apple then most of the seedlings are good keepers. Size has not been as constant as some other characteristics. Where there is a marked difference in size between the majority of the seedlings and the female parent it is in the direction of larger fruit in the seedlings. For instance, the fruit of the seedlings of American Golden Russet, Swayzie, and Fameuse average larger than the parent. Where seed has been examined carefully it has been noted that as far as size of seed is concerned the seed of the majority of the seedlings resembles the female parent. The varieties which gave seedlings which had the most characteristics of the female parent are Wealthy, Gano, McIntosh, and Langford Beauty. Those least resembling the female parent are Swayzie and Fameuse. The seedlings of Fameuse have been the most disappointing of all, there being a large proportion of varieties of inferior quality. The largest proportion of promising

seedlings are among McIntosh, Langford Beauty, Northern Spy, and Wealthy. Of the fifty-odd varieties which have been named the following are the most promising:

McIntosh seedlings: Lobo, Melba, Carno, Nemo, Joyce and Brock.

Langford Beauty seedlings: Kim, Ripon, Horace, Kildare, Gerald, Cora, Sonora.

Northern Spy seedlings: Rocket, Thurso, Rosalie, Clinton, Glenton, Bingo, Parma, Cecil, Nestor and Niobe.

Wealthy seedlings: Mendel, Luke, Galetta, Pinto, Medford, Battle, Melvin, Crusoe.

Lawver seedlings: Cobalt, Danville.

Shiawassee seedlings: Petrel.

Salome seedlings: Nepean, Rouleau.

Scott Winter seedlings: Bruno.

Fameuse seedlings: Herald.

Gano seedlings: Roger.

Swayzie seedlings: Ottawa, Radnor.

Winter St. Lawrence seedlings: Linton, Atlas, Nile, Albert, Anson.

As there are very few winter apples hardy enough for the colder parts of Canada where the apple is grown successfully, these new varieties, of which about half are winter apples, should prove of great value, and they are being propagated with a view to a more extended test of them. As this kind of apple breeding had given such good results, seed was saved in 1908 of some more of the best hardy winter apples grown at Ottawa, including Milwaukee, Bethel, Winter Rose Baxter, LaVictoire, and Stone from which we have about 1500 trees, part of which have been already planted in the orchard.

As it is important to obtain apples suitable for the prairie provinces of Canada as soon as possible, another method than that followed by Dr. Saunders is being practiced by the writer. Seed was sown in 1910 of some of the hardiest Russian apples, including Transparent, Charlamoff, Beautiful Arcad, Oldenburg, Tetofsky, Anis, Antonovka, and Hiberna. From these, over 17,000 seedlings have been raised and next spring these will be sent to the Dominion Experimental Farms in the Canadian Northwest and planted close together in nursery rows. After three years any which prove hardy up to that time will be removed to an orchard for further test. A much larger quantity of seed of other hardy varieties was sown in the autumn of 1911, and it is planned to continue this work from year to year in the hope that from some of these hardy Russians which stand so much cold in Russia will be obtained some which will be useful in the cold districts of Canada, where early growth in the spring followed by frost seems as destructive as low temperatures of winter.

Cross-breeding apples in the horticultural division.—Although considerable attention has been paid to the raising of naturally pollinized seedling apples by the writer, cross-breeding has not been neglected. The work of cross-breeding apples was begun by the writer in 1899 and has been continued from time to time since, although the opportunities for this work have been so limited that comparatively little crossing could be done in any one year. In 1900 I was assisted in this work by Mr. D. T. Elderkin, and in the year 1909 and 1910 by Mr. J. F. Watson. There are now between 800 and 900 different cross-bred trees growing as the result of this work. In order to make the chances of obtaining desirable apples greater, quite a number of varieties have been used as parents, in most cases reciprocal crosses with the same varieties having been made, thus making many more combinations than the number of varieties might indicate. The varieties used as parents have been Anis, Anisim, Antonovka, Baxter, Bethel, Oldenburg, Dyer, Fameuse, Forest, Hiberna, Lawver, Lowland Raspberry, Malinda, Milwaukee, McIntosh, McMahan, Newton, Northern Spy, Northwestern Greening, Scott Winter, Stone, Winter Rose, and Walton.

But few of the cross-bred trees have yet fruited, but those that have indicate that desirable characters of both parents can be obtained in the crosses. For instance, crosses between the Lawver and McIntosh, the former a very long-keeping apple, have resulted in some varieties that are better keepers than the McIntosh and better in quality than Lawver. In this particular cross, however, the character of "lack of hardiness" in Lawver was not known when the crosses were made. For which reason, doubtless, a large proportion of the seedlings show lack of hardiness and vigor.

It is intended to continue apple breeding in Canada, both from naturally pollinized flowers and from artificially pollinized flowers, and it will be our endeavor while obtaining results of immediate practical value to keep such records as may help to assist plant breeders in arriving at surer methods of obtaining the results desired.

Experiments in breeding apples by bud-variation are also in progress. During the past 14 seasons records have been kept of the yields from individual trees in the orchards at the Central Experimental Farm, Ottawa, and marked differences in yield have been recorded. Trees of the Wealthy apple propagated from heavy, light, and annual bearing trees are being grown to find if this habit is continued. These trees are now beginning to bear, and we look for some interesting results soon. We have also the different strains top-grafted on the same tree.