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SDSU Agricultural Experiment Station

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## Root-Killing of Apple Trees

N.E. Hansen

*South Dakota Agricultural College*

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Bulletin 65.

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U. S.  
EXPERIMENT STATION  
SOUTH DAKOTA.



IN CONNECTION WITH THE  
SOUTH DAKOTA AGRICULTURAL COLLEGE.

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ROOT-KILLING OF APPLE TREES.

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DEPARTMENT OF HORTICULTURE.

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BROOKINGS, SOUTH DAKOTA.



SIoux FALLS, S. D.  
WILL A. BEACH, PRINTER AND BINDER.  
1899.

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# ROOT-KILLING OF APPLE TREES.

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## DEPARTMENT OF HORTICULTURE.

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N. E. HANSEN, Horticulturist.

The past winter has wrought widespread destruction in the northwestern nurseries and young orchards, and the afflicted area extends far to the south. Hundreds of thousands of apple root-grafts have been root-killed, and the tales of woe come from very many localities, even from Missouri. The winter of 1872-73 will long be remembered by fruit men for devastation wrought; the winter of 1884-85 was as bad and now that of 1898-99 is added to the list.

At Brookings we find apple root-grafts root-kill every winter unless deeply covered. Nearly six thousand were root-killed in the winter of 1896-97. Root-grafts that had made a good growth in 1897 were taken up in the fall of 1897 and wintered in cellar. Root-grafts made in the winter of 1897-98 were planted at the same time in the spring of 1898. Both lots root-killed. In all hardy varieties we find the scion alive and sound, but the American seedling root dead. Both Vermont apple and French crab seedlings root-killed. The Hibernial and other hardy varieties had not rooted sufficiently from the scion to carry the tree through; indeed, the past winter the scion-roots of all (even Hibernial and Duchess) of the cultivated varieties winter-killed. So that "piece root-grafting with a long scion and a short root to get trees to root from the scion" will not avail in winters like that of 1898-99. Over 900 seedlings were grown in 1896 from seed of wild crabs gathered near Des Moines, Iowa, but all save one plant were killed the first winter. A similar number of French crab seedlings were planted in the spring of 1898, but not a



solitary plant survived the past winter. Will the experience of the past winter change nursery methods? Probably very little, except in the northern nurseries. Commercial methods change slowly, and the test winters do not come often enough to compel a quick changing. Certain it is that the western American method of winter root-grafting makes possible the production of apple trees at prices lower than those of Europe with cheap labor.

It may be of interest to call attention to the fact that in Russia the growers in the northern fruit-growing regions have had the same trouble with root-killing, that our tale of woe was theirs also years ago, but that they have met and solved the problem and are now masters of the situation.

In 1894, with the kindly assistance and advice of my teacher, Prof. J. L. Budd, the writer visited the Imperial Agricultural College at Moscow, Russia, and in 1897 the visit was repeated when sent on a tour of exploration by Hon. James Wilson, Secretary of Agriculture, to secure new seeds and plants for the United States Department of Agriculture, in the dry parts of eastern Russia, Central Asia, China and Siberia. Prof. R. Schroeder, the venerable head of the horticultural department, has been in the government service over fifty years. He said that the Russian method of preventing the root-killing of apple trees was to use the true Siberian crab, *Pyrus baccata*, as a stock. The seedlings are transplanted into nursery rows and budded at the usual time in August. The trees make a good growth in the nursery, bear at least two years earlier in orchard, and are dwarfed somewhat in size of tree. In the southern parts of Russia, as at Kiev, where even French pears are grown, I found the nursery stocks to be mostly ordinary apple seedlings from Germany and France, as they were cheaper than apple seedlings of Russian origin, which were difficult to obtain in commercial quantities. (A similar state of affairs obtains in our eastern states where crab seedlings imported from France, or grown from imported seed, are at times cheaper than seedlings from seed saved at our own cider mills.)

*Pyrus baccata* is the hardiest known species of the apple and is hardy even at the agricultural experiment station at Indian Head, about 350 miles west of Winnipeg on the Canadian Pacific Railway, where the thermometer registers at times 52 degrees or more below zero. It is found especially in the Transbaikal section of Siberia, east of Lake Baikal, where the climate is purely continental. The coldest month has a temperature of  $-28$  degrees C (or  $-18.4$  degrees Fahrenheit), the hottest month 19 degrees C. (or 66.2 degrees Fahrenheit). Difference between winter and summer temperature 42 degrees C. (or 75.6 Fahrenheit). The mean annual temperature is  $-2\frac{3}{4}$  degrees C. (or 27.05 degrees Fahrenheit). A Russian government report\* says: "As for the mean temperature of the vegetative period, although it is  $\frac{1}{2}$  degree below that of the cultivated zone of eastern Siberia, amounting to only 13.5 degrees, yet the cereals, notwithstanding the constantly frozen soil in some places of this country at a depth of  $1\frac{1}{2}$  arshine (42 inches), ripen well, thanks to the more powerful action of the sun's rays, depending not only on the southerly situation of the Transbaikal, but also on the cloudless and transparent atmosphere, as compared with the cultivated regions of Eastern and Western Siberia.

"In reference to the amount of rainfall, the climate of Transbaikalia is also incomparably more continental than that of the agricultural zone of Eastern and Western Siberia. The quantity of moisture precipitated here in the course of the whole year does not exceed 290 millimeters (11.42 inches), instead of the 360 and 380 of the agricultural zones of Eastern and Western Siberia, while the winters are almost entirely snowless, with 13 millimeters (.51 inches) during the whole season. Fortunately the summer rainfall, as much as 200 millimeters (7.87 inches), is considerably higher not only than that in Eastern but than that in Western Siberia, and the conjunction of these conditions explains the fact that the Transbaikal country may even to-day be considered the chief granary of the whole Amour-Littoral region."

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\*"The Industries of Russia," Vol. V, p. 56, St. Petersburg, 1893.

The above facts tend to show why *Pyrus baccata* does not root-kill in Russia, Dakota, or Assinaboia. Young seedlings of this species raised last year at Brookings from seed obtained by the writer while in Russia, as well as one-year-old trees secured in Russia at the same time, came through last winter in perfect condition.

Plate No. 1 shows a one-year-old tree of *Pyrus baccata odorata* whip-grafted on a piece-root of Vermont apple seedling. The seedling was grown by a western nurseryman from Vermont seed. The scion was cut from a tree imported from Germany early in the winter of 1897-98. The graft was made in the winter of 1897-98, planted the following spring, and made a growth of 17 inches the first year. Among a lot of over 3,000 root-grafts root-killed in the winter of 1898-99 (minimum temperature forty degrees below zero Fahrenheit with no snow on the ground), this tree was conspicuous for its vigorous growth from the terminal bud. Careful digging soon furnished the explanation. The scion E. to A. of the original graft was alive and healthy; the Vermont apple root A. to B. was dead and the sap had fermented. The scion had, however, thrown out the strong root C. to D.; this was perfectly healthy and enabled the scion to begin a vigorous growth. The only part of the entire tree affected by the winter was the part A. to B.

The following table gives the list of piece-root grafts on Vermont seedlings planted in the spring of 1896 and root-killed in the winter of 1896-7. The first column gives number showing signs of life in the spring by leafing out; this was usually due to the roots thrown out by the scion, but in most cases these roots were too slender to save the scion and it soon died. Virginia crab showed the largest percentage of scion-rooted trees, showing 101 out of 645. Of the grafts that did not leaf out the scion in nearly all was alive and sound, but the Vermont seedling root being entirely dead and no scion-roots having been thrown out, the scion was simply like an apple tree cutting stuck in the ground and soon dried up.



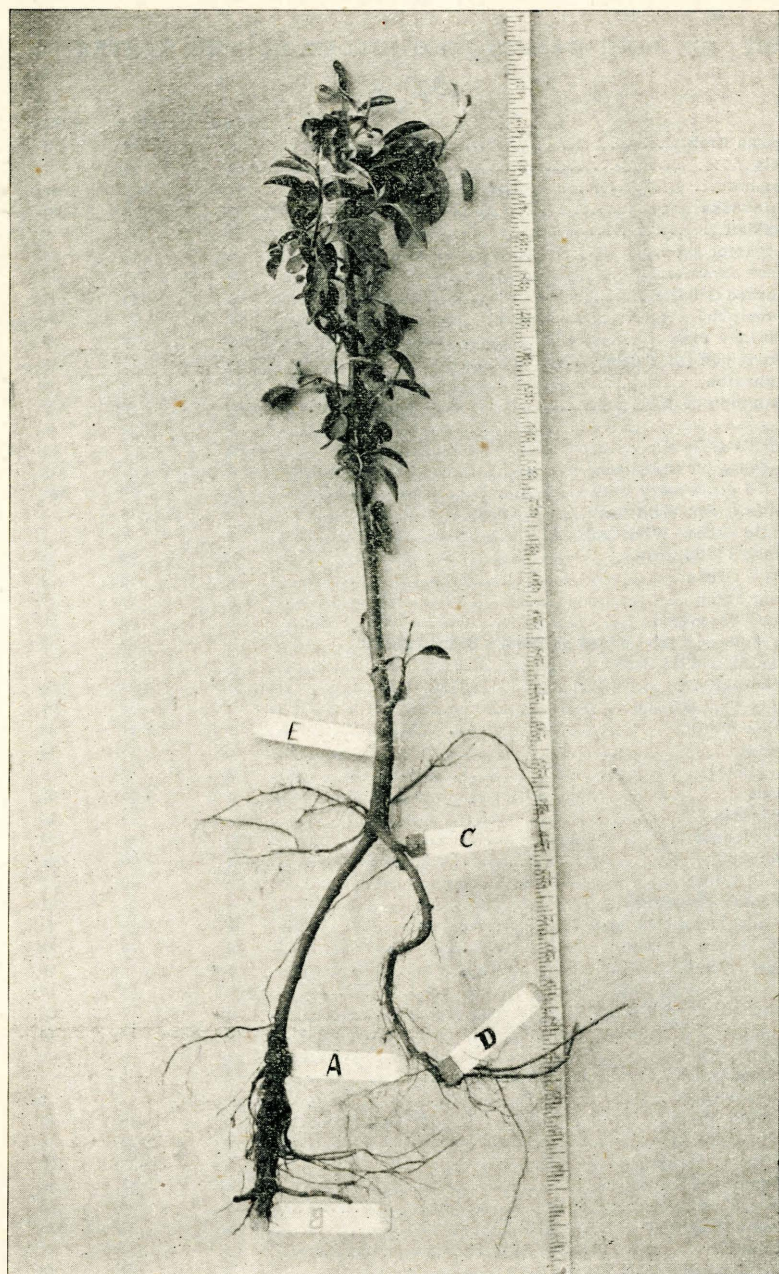


PLATE I.



LIST OF ROOT-GRAFTS ROOT-KILLED IN THE WINTER OF  
1896-97.

	ALIVE	DEAD	TOTAL
Alaska Crab.....	4	75	79
Anis.....	3	99	102
Anisim.....	36	264	300
Antonovka.....	12	214	226
Arabian.....	1	111	112
Bergamot, 424.....	2	45	47
Black Swan.....	0	13	13
Blushed Calville.....	4	43	47
Borovinka.....	8	42	50
Browney Pine.....	9	69	78
Charlamoff (of Tuttle).....	2	11	13
Cinnamon.....	0	8	8
Crampton Crab.....	26	100	126
Cresco.....	0	4	4
Dartt's Hybrid.....	22	27	49
Duchess of Oldenburg.....	0	13	13
Early Strawberry Crab.....	13	88	101
Ent's Green Wild Crab.....	0	2	2
Ent's Yellow Wild Crab.....	0	1	1
Fluke's Wild Crab.....	0	38	38
Glass Green.....	0	43	43
Gold Patch.....	0	17	17
Good Peasant.....	8	27	35
Greenwood Crab budded on Dartt's Hybrid grafts.....	1	52	53
Hamilton Wild Crab.....	0	7	7
Hibernal.....	92	902	994
Juicy Transparent.....	2	82	84
Juicy White.....	1	41	42
Kaump.....	0	36	36
Lawrence.....	0	17	17
Lead.....	1	96	97
Ledenets.....	1	18	19
Longfellow.....	12	27	39
Longfield.....	71	880	951
Long White.....	8	49	57
Lowland Raspberry.....	3	31	34
Lubsk Queen (No. 444).....	0	32	32
MacMahan's White.....	10	10	20
Martha Crab.....	3	41	44
Mathews' Wild Crab.....	0	70	70
Mitchell's Red Warrior.....	5	7	12
Ness.....	0	12	12
Oligar No. 2.....	0	1	1
Oligar No. 6.....	0	2	2
Oligar No. 8.....	0	2	2
Oligar No. 10.....	0	10	10
Oligar No. 14.....	0	14	14
Patten's Greening.....	5	102	107
Recumbent No. 240.....	8	336	344
Red Queen.....	1	49	50
Repka Malenka.....	4	124	128
Serinkia.....	1	10	11
Shields Crab.....	3	31	34
Solon Wild Crab.....	0	11	11
Sonlard Wild Crab.....	0	36	36

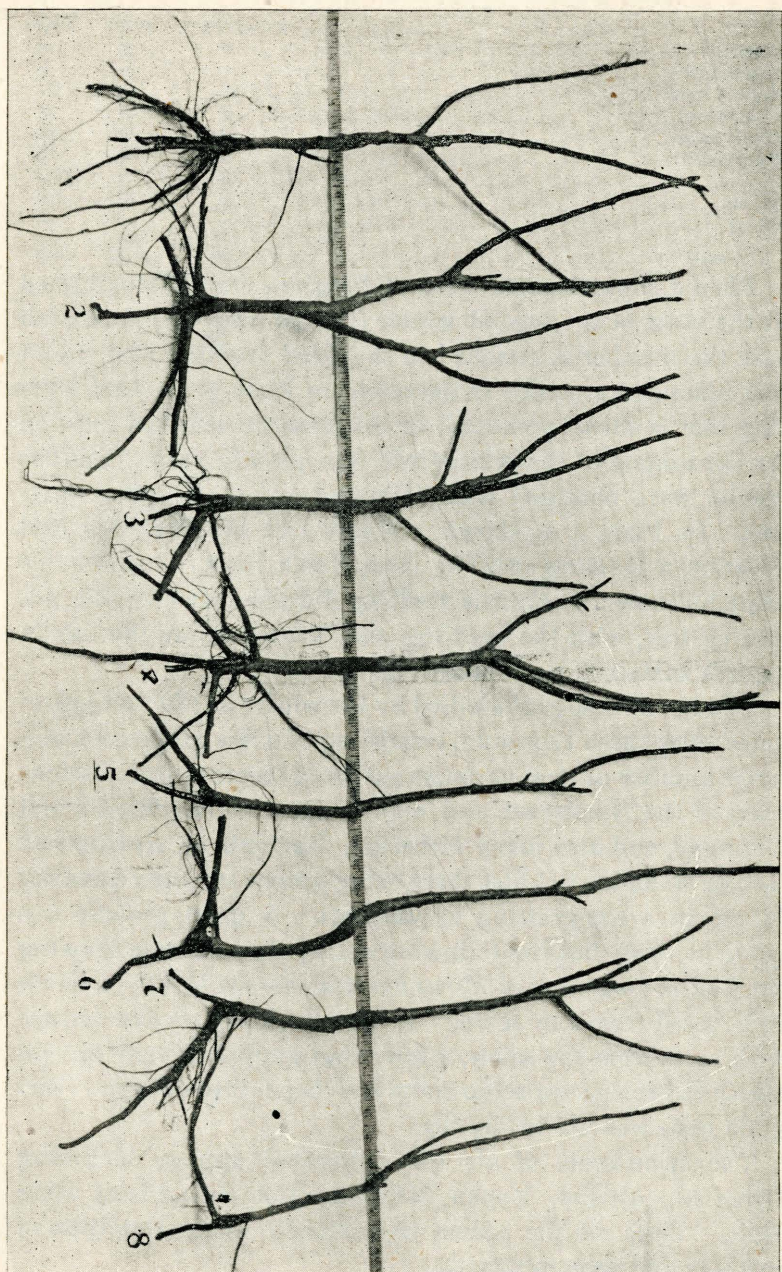


PLATE II.



	ALIVE	DEAD	TOTAL
Thaler.....	0	31	31
Tiesenhausen.....	1	34	35
Virginia Crab.....	101	645	746
X (label lost).....	6	16	16
Yellow Sweet.....	12	89	101
Watermelon.....	0	10	10
4 A.....	0	12	12
No. 272.....	2	63	65
No. 375.....	4	42	46
Totals.....	502	5434	5936

Plate 2 shows sample trees of Virginia crab photographed at the close of the second winter (that of 1897-98). In each case the number is attached to the dead seedling root which had remained attached to the scion; in Plate 3 the dead seedling root is shown removed, in all cases the original incision for the tongue of the whip-graft was plainly seen. Similar results were obtained with Hiberna and many other varieties. In Plate 4 is shown a single tree of Mitchell's Red Warrior, a Duchess seedling from North Iowa, in which for some unknown reason the seedling did not root-kill; the adjoining tree, with the seedling root killed, shows the loss in growth sustained by root-killing.

The list of root-grafts killed by the winter of 1897-98 aggregated over three thousand, consisting of a few grafts each of a large number of new varieties gathered together from various parts of the Northwest and many imported from Russia and Germany, and also many Hiberna, Recumbent, Anisim and Repka Malenka, the first three being grown in larger quantity for use in a top-grafting experiment. A good growth was made in 1898, but the following spring the only tree showing signs of life was that of *Pyrus baccata odorata* (Plate 1) which had rooted from the scion. It was the only *Pyrus baccata* with roots from the scion; a few other grafts of *Pyrus baccata* perished because no scion-roots had been thrown out. Virginia crab was not in the list.

The scion-roots of all the cultivated apples, including Hiberna, Anisim, Repka Malenka, and Recumbent were dead. Thus all the scions were simply in the condition of cuttings and soon perished.

Many of the scions were killed or badly hurt by the win-



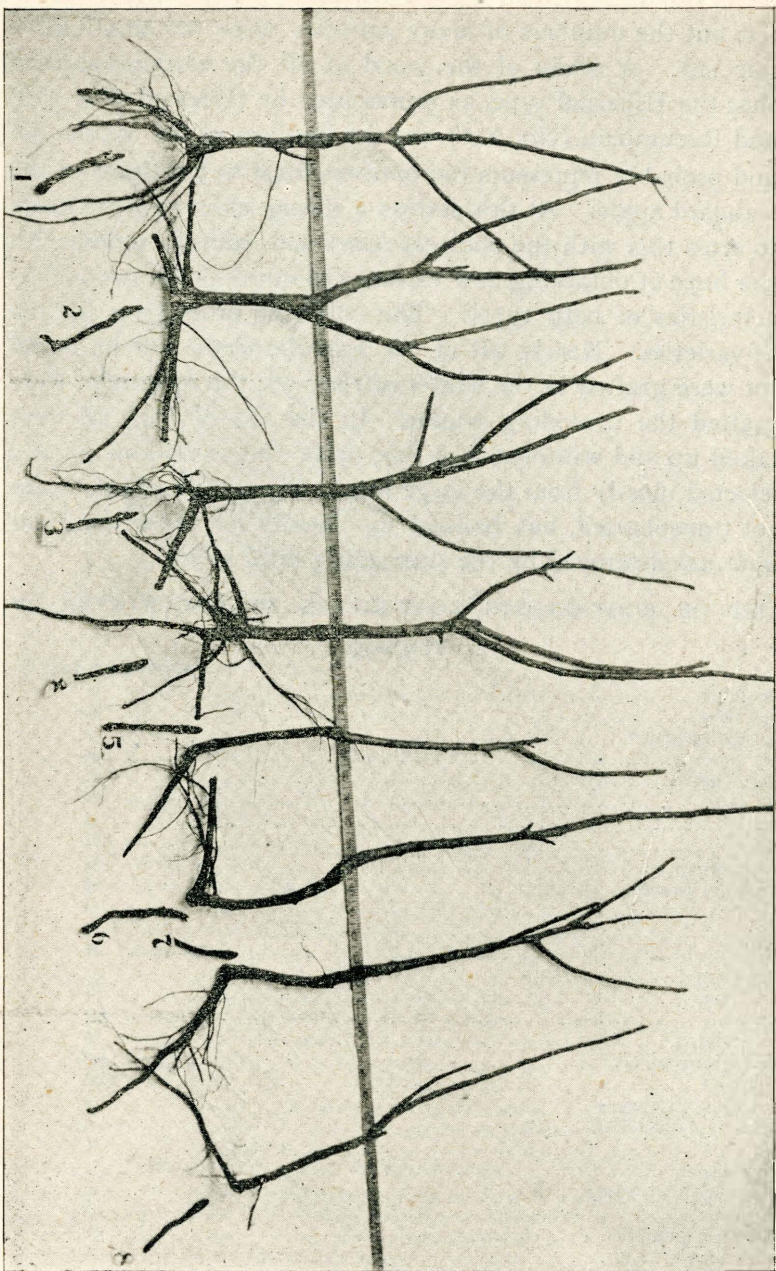


PLATE III.

ter, but the numbers of many varieties were too small for a fair test. A study of the wood of all the varieties showed that the Hibernial type, as represented by Hibernial (No. 378) and Recumbent (No. 240) was the hardiest of the whole list and probably represents the extreme limit in hardiness of the standard apple. At this station a strong effort will be made to cross this with the choicest American winter apples, with the hope of obtaining new varieties combining the good characteristics of both types. The following table gives the list of varieties. Nearly all of the miscellaneous and imported lot were grafted in the winter of 1897-98; the remainder were grafted the preceding winter. In the fall of 1897 all were taken up and wintered in cellar, with the exception of 285 selected mostly from the large lots. These 285 plants were not transplanted, but banked up heavily for the winter, and were not destroyed by the succeeding mild winter.

LIST OF ROOT-GRAFTS ROOT-KILLED IN THE WINTER OF  
1898-99.

	NUMBER OF GRAFTS.
No. 56 Vor .....	11
Red Wine.....	18
Muscat Russian T.....	18
Cal. Aport.....	25
No. 7 Orel.....	11
No. 12 M.....	10
Barloff.....	13
No. 252.....	28
Black Sinap.....	34
Beautiful Arcade.....	46
Avista .....	19
No. 361.....	25
Wolf River.....	11
Unknown .....	32
Kreidners .....	71
Anisim.....	314
Longfield.....	56
Recumbent No. 240.....	300
Hibernial.....	1380
Lowland Champagne .....	10
Duchess of Oldenburg.....	3
Surtzer .....	6
Rosenhager .....	11
Sweet Seedling, Tuttle .....	9
Romenskoe.....	13
Fluke's Wild Crab.....	12
Long Arcade.....	18
No. 502.....	26
Glass Green.....	27



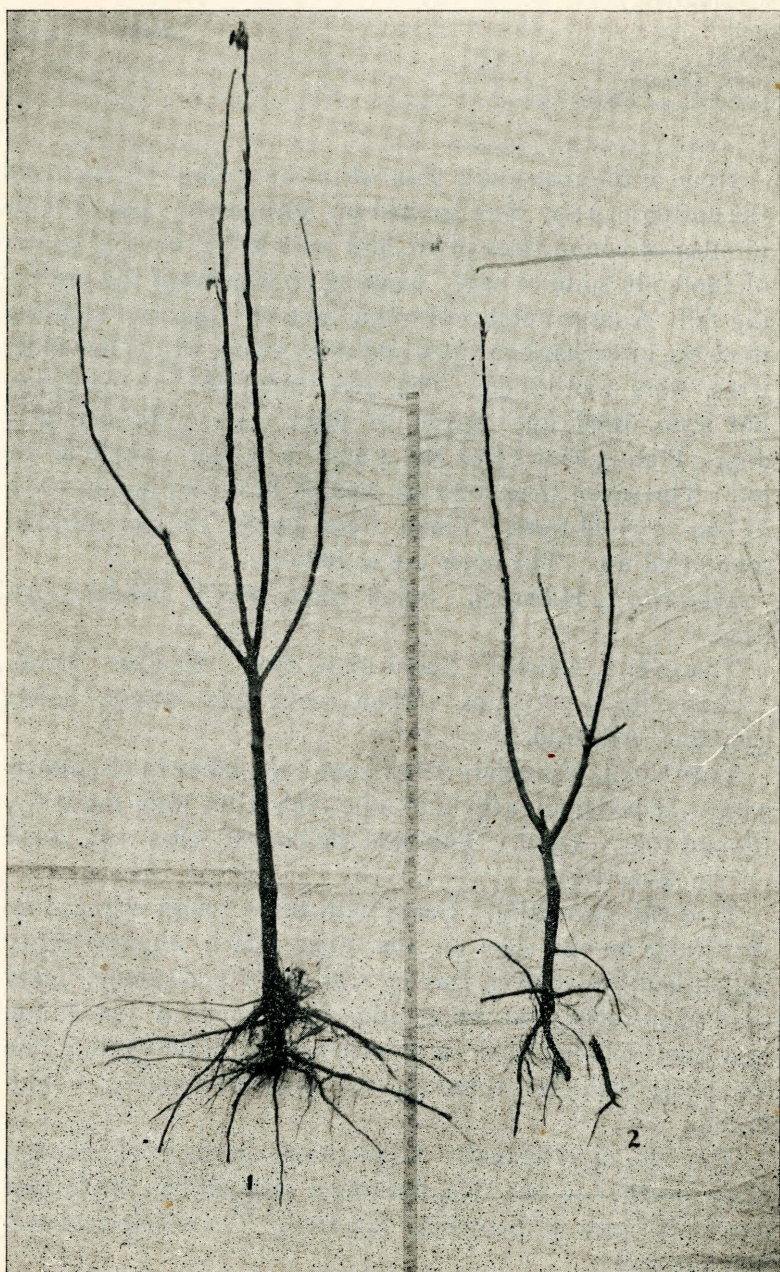


PLATE IV.



	NUMBER OF GRAFTS
No. 541.....	9
Repka Malenka.....	437
Miscellaneous and imported.....	307
Total.....	3310

None of the root-grafts planted in the spring of 1896 and the spring of 1897 were banked up with earth, but a large number of young trees in orchard were killed in the winter of 1898-9 in spite of heavy banking up with earth the preceding fall. A large number of young trees on American seedling roots set in orchard one, two and three years, with a few older trees, were root-killed. The tops leafed out in most cases, but soon dried up. Seven of these trees were carefully dug. Plate 5 shows tree No. 4 and is a fair sample of the lot. The seven trees were all planted in the spring of 1896, as two-year-old trees. These trees began to leaf out, but soon dried up. The notes are as follows:

Tree No. 1, Hibernial. Scion roots, seven, slender. All dead.

Tree No. 2, Anisim. Scion roots, two. Slender. Dead.

Tree No. 3, Anisim. Scion roots, one strong, seven smaller. All dead.

Tree No. 4, Hibernial; Scion root  $2\frac{3}{4}$  inches in circumference near body; alive the first nine inches out from the body, beyond that. Dead. This was the largest scion-root found on the seven trees.

Tree No. 5, Anisim. Scion with three rough walnut-like root-knots on one side; on the other side a nursery injury which had healed over, leaving scar three inches long. Only two scion-roots: one proceeding from between two of the root-knots one-half inch in diameter, soon dividing into fine branches; the other three-eighths inch in diameter. Both dead.

Tree No. 6, Hibernial. Scion roots, seven, very slender, close together on one side, forming a semi-circle, the largest one-fourth inch in diameter. All dead. The whole root system one-sided.

Tree No. 7, Hibernial. Scion roots, two, one-half inch

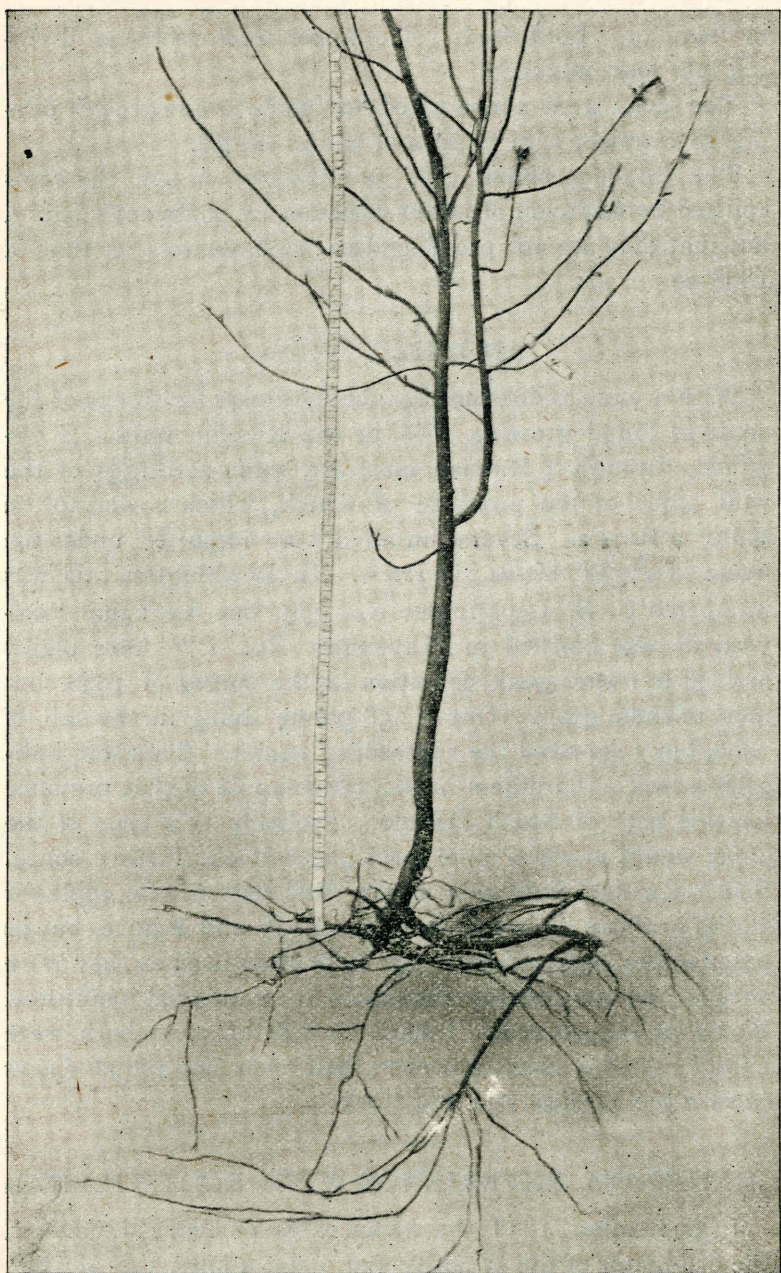


PLATE V.



in diameter. Both dead. The upper scion root soon dividing into four branches.

The seven trees above noted had made a fine growth during 1896-97-98, with no sign of winter injury.

The evidence shows that in ordinary winters the roots emitted by the scion of hardy varieties are sufficiently hardy, but that they are not proof against such winters as that of 1898-99.

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### ANOTHER TRIAL.

With a view to determining the hardiness for stocks of the apple as found growing wild in the Russian forests, I obtained, through a Russian collector, some seedlings of the wild apple of the province of Kursk, which is well to the south in Russia. Several hundred were imported under the name of *Pyrus Malus sylvestris*. In Washington this was numbered U. S. Department No. 374, but the name "sylvestris" was omitted in "Inventory No. 1." The plants arrived in rather weak condition in the spring of 1898, but most of them grew. Out of 258 plants living in the fall of 1898, but 3 survived the succeeding winter. This test indicates a lack of hardiness in the native apple of that province for this part of South Dakota. Probably this type of the apple would prove of more service as a stock, further south. South Russian fruit men prefer their native wild apple for stocks to those imported from Germany and France, but in practice the imported seedlings were often used as they were cheaper and more readily obtainable in commercial quantities. When far enough south it made no difference, as both were hardy. At the north, however, fruit men had found *Pyrus baccata* the hardiest and best stock.

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### MINNESOTA EXPERIENCE WITH ROOT-KILLING.

In September, 1898, the writer called on Peter M. Gideon, the originator of the Wealthy and Peter apples, the Martha, Florence, Lou and October crabs, and many other varieties



of apples and crabs. Mr. Gideon began his experiments in fruit culture about 45 years ago and has grown and sent out many thousands of seedlings, chiefly of Siberian crabs. Mr. Gideon's fruit farm is situated near the shore of Lake Minnetonka at Excelsior, Minnesota. In reply to a question Mr. Gideon said: "If the ground is moist in the fall an ordinary apple seedling will not root-kill; if dry, it will. But a Siberian crab root will come out all right and not root-kill on dry soil, while every American seedling root will winter-kill. Even a Siberian root sticking out of the ground after digging, I have known to form a terminal bud and make a tree. A mulch is always good in the fall to prevent root-killing. I have often had hardy varieties in nursery with all the American seedling roots dead in the spring, but a single root which had come from the scion had survived the winter, and this pulled the tree through. We greatly need hardy stocks for the apple used in a commercial way. In my opinion, no hardier stocks could be grown than those of the iron-clad cross-bred Siberian seedlings I have sent out."

#### VARIETIES OF PYRUS BACCATA.

In this connection it will be of interest to give the late Dr. E. Regel's description of this species. Dr. Regel was for many years director of the Imperial Botanic Gardens at St. Petersburg. The following extract from Regel's "Russian Dendrology" (Vol. IV, P. 269, St. Petersburg, 1874), was translated for me while in Russia in 1897, from Russian into German, by a translator at the St. Petersburg Botanic Gardens, and I have rendered this into English, as follows:

##### THE SIBERIAN APPLE TREE, *Pyrus baccata* L.

The leaves are oval, tapering, flat, shining on the upper surface, light green, sharply toothed on the margin. The petioles are usually longer than one-half of the leaf surface. The fruits are borne on long thin stalks, which are several times longer than the fruit and are attached to the same in a depression on the base [cavity]. The calyx is cast off

towards the time of ripening, through which characteristic *Pyrus baccata* is easily distinguished from *Pyrus prunifolia*, to which it is closely related.

*Pyrus baccata* flourishes throughout all Siberia into northern Japan and on that account deserves consideration, because it is one of our best and hardiest trees for the garden. The large white or reddish blossoms are set on one-colored stalks arranged umbrella-fashion. The calyx is externally flat, on the inside downy. The style is flat. *Pyrus baccata* is in full blossom the end of May and in June. The red cherry-like fruits of several of the varieties serve in the fall to beautify gardens and parks. The fruits of other varieties are used, when they have been touched by frost, for preserves; or, in spite of a certain acerbity, as a delicacy by the peasantry, as, for example, the fruit of *P. prunifolia*.

In the *Gartenflora*, 1862, and in the "Russischen Pomologie" (Russian Pomology), Vol. 1, figures g, i, k and l, the most beautiful varieties of this tree are figured. These varieties are as follows:

1. *Genuina*. The fruits are nearly spherical, approximately of the size of a large currant; the ripe fruits are yellowish-purple. This variety is in its wild state the most widely distributed. Figured in *Gartenflora*, p. 364, fig. 2. Guimp. fr. Holzgen, p. 126.

2. *Praecox*. The fruits are very small, the size of a common currant, dull purple when ripe, transparent after the first frosts. The flavor is milder. Figured in *Gartenflora*, p. 364, fig. 3. Russ. Pomologie I, fig. h.

3. *Oblonga*. The fruits are elongated oval, five-eighths inch in length and not much smaller in breadth; blood red when ripe.

4. *Aurantiaca*. The fruits are roundish oblate, [flattened] often ribbed; when ripe, orange colored, with dark narrow stripes; five-eighths inch in length,  $\frac{3}{4}$  inch in breadth. Figured in *Gartenflora* page 364, fig. 4 Russ. Pomologie I, fig. i.

5. *Macrocarpa*. The fruits are roundish oblate,  $\frac{3}{8}$  inch in length and somewhat more in breadth. When ripe, yellow, with red on the sunny side.

6. *Cerasiformis*. The fruits resemble in size and form a moderate sized cherry, elliptical, ribbed,  $\frac{5}{8}$  inch in length and breadth. When ripe, yellow; later, scarlet red on the sunny side or over the entire surface. In fruit gardens this variety is known under the name "Chinese apple tree". The fruit is used chiefly for preserves. The tree presents a beautiful appearance in autumn. Figured in *Gartenflora*, p. 364, fig. 1. Russ. Pom. I, fig. 1, synonym: *P. cerasiformis*, Turt.

7. *Conocarpa*. The fruits are conical, with a broad base tapering at the apex, five-eighths inch in length, ribbed, blood red when ripe.

8. *Edulis*. Very similar to the variety *cerasiformis*, the fruit however is of a more pleasant flavor. It is the best variety for preserves.

9. *Costata*. Fruit oblate round,  $\frac{3}{4}$  inch in breadth,  $\frac{1}{2}$  inch in length, ribbed, blood red when ripe.

10. *Sanguinea*. Similar to the preceding variety. The fruits are, however, not ribbed.

11. *Lutea*. Fruits the same as that of variety *genuina*, but when ripe, yellow with red cheek.

12. *Obconoidea*. The fruits have a narrow base. are obconical, ribbed,  $\frac{5}{8}$  inch in breadth. When ripe, orange yellow with red tracing.

In this connection it will be well to give Dr. Regel's description of *Pyrus prunifolia*, commonly called the large fruited Siberian crab; translated from the same source in the same manner (Regel's "Russian Dendrology", Vol. IV., p. 266).

#### *PYRUS PRUNIFOLIA, WILLD.*

A tree of medium size which attains a height of up to thirty feet and endures the severest frosts. The leaves are oval or broadly oval, obtusely pointed, serrate. The petiole is usually longer than half the leaf, when young the petiole, as well as the leaf, slightly pubescent, later quite smooth. The leaves are light green, yet not so shining as those of *Pyrus baccata*. The leaves are sharply saw-toothed, the serrations short and sharply pointed. The flowers are large,



white, sometimes with reddish cast, borne in great numbers on the ends of the short side shoots. The one-colored slender flower stalks are united in close clusters. The inner side of the calyx and the lower part of the pistil are usually covered with white pubescence. The calyx segments are persistent in the basin of the ripe fruit, this characteristic distinguishes *Pyrus prunifolia* from *Pyrus baccata*. The slender fruit stems are longer than the ripe fruit and are set in the depression on the base of the fruit [cavity]. The flavor of the fruit is sour, somewhat bitter; there are, however, varieties with milder flavor; these varieties are in all cases the most resistant of our hardier Russian apple trees. *Pyrus prunifolia* is one of our trees with beautiful blossoms; at the end of May and the beginning of June this tree is covered with handsome white and reddish flowers. The form of the fruits is much varied; some of them are so beautiful that as they ripen in autumn the tree is decorated for the second time. These fruits are cherry-shaped, from one-half to one and one half inches long, and cover the tree in immense numbers.

The varieties are as follows:

1. *Suaveolens*. Large flowers; reddish externally, fragrant, on which account this tree is adapted for gardens.
2. *Microcarpa*. Fruits small, oval, red at maturity.
3. *Oviformis*. Fruits ovate, when ripe yellow with red tracing. Figured in Regel's Gartenflora, p. 364, fig. II., Rus. Pom. I. fig. h.
4. *Conocarpa*. Fruits conical, with oval base, when ripe, green with red on the sunny side.
5. *Intermedia*. The fruits are flattened-spherical, ribbed, yellow when ripe, blood red on the sunny side,  $\frac{7}{8}$  inch in length,  $1\frac{1}{8}$  inch in breadth. Figured in Gartenflora, p. 364, fig. 9, Rus. Pom. I. fig. d.
6. *Chlorocarpa*. Fruits either spherical or flattened-spherical, when ripe, green, with red on the sunny side.
7. *Xanthocarpa*. Fruits roundish-oval, when ripe yellow,  $\frac{3}{4}$  inch in length, less in breadth.

8. *Calvillea*. Fruits oval or nearly spherical, ribbed when ripe scarlet-red, about one inch in length and breadth. In autumn this variety is very handsome. The fruits are used for preserving; they are very similar to *P. baccata cerasifera*, but are distinguished by the fact that the calyx segments do not fall off from the ripe fruit.

Synonym: *P. cerasifera*, Tausich var. *calvillea*. Figured in Gartenflora, p. 364, fig. 8, Rus. Pom. I fig. c.

9. *Macrocarpa*. The fruits are one inch in length and breadth, nearly spherical, ribbed, when ripe, green. Figured in Gartenflora, p. 364, fig. 10, Rus. Pom. I. fig. i.

10. *Striata*. Fruits oval, one inch in length, when ripe yellow with dark red stripes.

*Pyrus prunifolia* flourishes in southeastern Russia and in southern Siberia. It is propagated from seed. The varieties preserve their characteristics only when grafted.

Very similar is *Pyrus spectabilis* Ait. from China; this grows, however, usually in bush form and is covered every year with abundant reddish blossoms.

*Pyrus Kaido*, *P. Ringo* and *P. armeniaca-folia* are garden varieties; they are not resistant to our winters.

#### LATER AUTHORITIES.

The full history of *Pyrus baccata* and *Pyrus prunifolia* in a state of nature and under cultivation is yet to be written. Since their introduction into America they have been grown in mixed orchards, especially in the western states, and very many hybrids with the cultivated apples have originated under cultivation. Many of these are too much subject to blight to be of value, while others are regarded as very valuable, especially in the prairie Northwest, owing to hardiness and productiveness.

The true *Pyrus baccata* has been neglected, owing to small size of fruit, and ignorance of its value as a hardy stock. As to the original home of these two species Dippel\* gives

\*Handbuch der Laubholzkunde, Dippel, Vol. III, p. 404, Berlin 1893.

eastern Siberia, China and the Himalayas as the native home of *Pyrus baccata*, and China and Japan (p. 398) as that of *Pyrus prunifolia*. Fr. Th. Koeppen in discussing the indigenous distribution in Russia of *Pyrus Malus*\* concludes as follows: (page 417.) "Finally in this connection should be named *Malus (Pyrus) prunifolia* Willd. which form, according to Regel, is said to grow in southeastern Russia (?) and in southern Russia. Meanwhile from the whole Russian empire I find not a single certain locality where it has been found (Fundortsangabe). Ledebour gives only Siberia (and this with a question mark) as the native habitat of this form."

Prof. L. H. Bailey refers crabs of the Transcendent and Hyslop type to *P. prunifolia* Willd., and considers them hybrids of the common apple and *Pyrus baccata*. After a visit to Berlin Prof. Bailey writes: [2] "Willdenow's type of *P. prunifolia*, preserved in Berlin, shows flowers and leaves and has the botanical characters of the Transcendent and Hyslop crabs. It is almost unmistakably a hybrid of *Pyrus Malus* and *P. baccata*."

Koehne † gives Siberia and North China as the habitat of *P. prunifolia* and the Himalayas, China, Amur province and Siberia as that of *P. baccata*. Dr. Regel, as has been noted, makes the deciduous calyx segments the distinguishing characteristic of *Pyrus baccata*. This characteristic is also emphasized by Dippel and Koehne. Koehne mentions *P. prunifolia* as having taken part in the evolution of our cultivated apples. Koehne and Dippel both use the older generic name *Malus* instead of *Pyrus*. Dippel gives *P. baccata odorata* (p. 404) with fragrant blossoms, as being probably a hybrid; Koehne (p. 261) considers this to be a hybrid of *baccata* and *prunifolia* ("*M. baccata* X *prunifolia*") and states there are many such hybrids which for the most part can not be de-

\*Geographische Verbreitung der Holzgewächse des Europaischen Russlands und des Kaukasus, Erster Theil, p. 404-417 in Vol. V of "Beiträge zur Kenntniss des Russischen Reiches und der angrenzenden Länder Asiens. St. Petersburg 1888; auf Kosten der Kaiserlichen Akademie der Wissenschaften, herausgegeben von L. V. Schrenck und C. J. Maximowicz.

[2] The Evolution of Our Native Fruits, Bailey. P. 272.

†Deutsche Dendrologie. Koehne p. 260, Stuttgart, 1893.



terminated without the fruit. This *odorata* variety, noted in Plate 4, as hardy at Brookings, was imported from the nursery of L. Spaeth, of Baumschulenweg, near Berlin, where Koehne made many of his observations.

Dr. Schroeder of Moscow, Russia, told me of having had good results with *Pyrus prunifolia* as a stock, but outside of Moscow I heard only of *P. baccata*.

The following article "Apple Seedlings for Stocks" was translated from Russian in the same manner as the notes from Regel's Russian Dendrology. It is from a work on "Commercial Horticulture" by Alexander Kondratevitch Grell (Moscow 1897), p. 65.

#### APPLE SEEDLINGS FOR STOCKS.

"Among the seedlings which are used for stocks, I give the preference above all to the Siberian 'berry apple' [crab]. There are two varieties of this species which are both used for the propagation of seedlings, viz., *Pyrus baccata*, var. *cerasiformis aurea* and *Pyrus baccata* var. *cerasiformis rubra*.

"The Siberian apple tree which is known in gardens under the erroneous name "Chinese apple tree" grows wild in southwest Siberia and northeast China, bears small round fruits, which are golden yellow in the first named variety and reddish in the second named variety. To this I count also a third species, useful in the highest degree but as yet but little distributed among us, viz., *Pyrus prunifolia* var. *macrocarpa*. Both of these species and their varieties are very pretty small trees which are laden every year with innumerable yellow or red fruits and give an extremely heavy crop of small seeds. The seedlings of the Siberian apple do not form so thick stems as those of the cultivated apple. When one grafts any desired garden variety on a Siberian crab, the stem below the point of union always remains thinner than above the same, hence an outgrowth arises at that place. When, on the contrary, the Siberian crab is grafted on a garden variety, the reverse condition arises, i. e., the stem beneath the point of union becomes thicker than above.

The local peasant nurserymen who are familiar with these characteristics, grow the Siberian crab for sale for stocks on forest or garden varieties.\*

"The Siberian crabs propagated in this manner grow faster than those grown from seed. Aside from the fact that the varieties grafted on a Siberian crab form neither too thick a stem nor a too thickly branched top, I give to the Siberian crab seedling above all the preference, and for two reasons: (1) Varieties grafted or budded on the Siberian crab bear much more and earlier fruit and (2) suffer much less from frosts. In a severe winter in the Borokow district in the Kaluga province all varieties of the apple were killed with the exception of a few which had been grafted on *Pyrus prunifolia macrocarpa*. Only these few escaped without injury. Since that time this species has been known only as the "unconquerable" in the Borokow district and in Wereja.

"Hence it is not at all necessary to search for other wildings for stocks, since there are present for us in *Pyrus prunifolia macrocarpa*, characteristics of such immense value. Some say that varieties grafted on the Siberian crab are not long lived, but this assertion is wholly without foundation, since a tree of *Pyrus baccata genuina* planted by me in Moscow, in 1859, is still growing and bearing fruit, and at M. F. Essen's is found one that has already reached its fiftieth year. Next after the Siberian crab, in hardiness and longevity, comes the forest apple wilding, and after that come the seedlings of garden varieties.

"The fruit of the Siberian crab is used for sauce, preserves, etc., and the seeds for the raising of new improved seedlings. After the ripe fruit has been gathered, the cores must be removed. This is done quite easily: Take a narrow thin strip of tin, sharpen one edge and wrap it around a round, slender lead pencil. The instrument is ready, and by pressing this small tube through the middle of the fruit, the whole core is removed and the flesh is left to be used for sauce, preserves, etc. A very good seedling for stocks is also *Pyrus*

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\*By this is meant *Pyrus Malus* which grows wild in parts of Russia.

*Malus*, which is found distributed far to the north. The seedlings of garden varieties are far inferior to the above named varieties. From six poods [equals 216 lbs. avoirdupois] of garden varieties, one obtains only one pound of good, large seeds, while from the same quantity of *Pyrus baccata cerasiformis* one obtains ten times; from *Pyrus prunifolia macrocarpa*, six to eight times, and from *Pyrus baccata genuina* one hundred times as many seeds, only that they are very small."

#### EARLY EXPERIMENTS IN WISCONSIN, IOWA AND MINNESOTA.

Experience in many orchards in the Northwest shows that the cultivated apple makes a poor union, as a rule, in top-grafting upon the Siberian crab. In most cases the top overgrows the stock. Some strong-growing varieties have kept pace with the apple top in growth, and are regarded as valuable for stocks. Earlier bearing and shorter life seems to be the effect upon many varieties when top-grafted upon Siberian crabs. A full investigation of these numerous experiments should be made. It would necessitate considerable traveling.

Piece-root-grafting on Siberian crab seedling roots, has been tried quite extensively, and the general experience is unfavorable. The early volumes of the annual reports of the Wisconsin, Iowa and Minnesota state horticultural societies contain a number of reports of unfavorable experience along this line. The Iowa reports also quote unfavorable Vermont experience.\*

In the reports the term "Siberian Crab" is used in nearly all cases, no distinction being made between *P. baccata* and *P. prunifolia*. The inference, however, may be made that they were chiefly of the *prunifolia* type, the true *P. baccata* being rare in cultivation, owing to the small size of the fruit. So far as the writer has been able to ascertain, the Russian

\*Wisconsin State Horticultural Society report: 1870-71 (referred to in later reports); 1879-80, p. 259; 1880-81, p. 190; 1881-82, p. 34-38; 1890, p. 115; 1892, p. 67.

Iowa State Horticultural Society report: 1873, p. 81; 1875, p. 153; 1875, p. 260; 1876, p. 224; 1876, p. 250; 1877, p. 396; 1882, p. 231.



method of budding at the collar on seedlings of *Pyrus baccata* already established in the nursery, has not been fully, if at all, tested. The chief objection to the trees root-grafted on Siberian crabs, appears to be the dwarfed growth of the tree. The only reference to budding, in the reports at hand, is by E. Wilcox, of LaCrosse, Wis., in the Wisconsin horticultural report for 1881-82, p. 36. Mr. Wilcox "budded a portion of his stock and thought the union was stronger and more perfect than where grafted." Mr. Wilcox expressed strong preference for the use of the Siberian crabs for stocks.

Budding may do better than root-grafting. A parallel case may be found in the case of the Mahaleb cherry. Cultivated cherries bud very readily on this stock, but unite with great difficulty in root-grafting.

The Russian method of budding on *Pyrus baccata* stocks, if found to be a good method in the prairie Northwest, will do away entirely with root-grafting in the winter, and make the trees somewhat more expensive. The dwarfing effect of this stock, already referred to in the citations from Russian experience, may not prove a disadvantage for the home orchards of the prairie Northwest, since on our rich prairie soils apple trees are prone to form wood instead of bearing fruit. Many varieties, otherwise valuable, suffer in public estimation because of their tardy bearing. This shy bearing has caused much interest of late years in girdling experiments. Mr. E. H. S. Dartt, of Owatonna, Minnesota, has already obtained some valuable results from his girdling experiments. Any dwarf stock tends to cause earlier bearing; it is in effect a mild form of girdling, the partial stoppage of sap at the point of union tending to force the sap to form fruit buds rather than wood buds.

In all sections where root-killing is not a source of constant trouble, the dwarfing tendency of the *Pyrus baccata* stock will probably be a fatal objection, at least for commercial orchards. The climatic conditions of the native home of this crab also lead to the opinion that it will be at home only at the North. In like manner, in Russia, the writer

found the stock used only at the North, while at Kiev, where French pears are grown, seedlings of the cultivated apple (*Pyrus Malus*) were used.

### SEEDLINGS OF HARDY APPLES.

The plan of growing stocks from hardy varieties of the cultivated apple (*Pyrus Malus*) has been proposed by many. The experiments at this station, although of limited extent, do not favor this view. Seed of many choice varieties secured at the state fairs and horticultural society meetings of Iowa, Minnesota and South Dakota, and from the station orchard, was saved and the seed planted in the spring of 1897. Cutworms were unusually numerous and destroyed a large number of the seedlings. The remaining seedlings came through the winter of 1897-8 in perfect condition, but were nearly all root-killed in the winter of 1898-99. Many were dead, root and branch. No winter protection, or mulch of any kind, was given either winter. Out of 187 trees examined, in the spring of 1899, eleven were selected for transplanting, although the wood was discolored, but by September we find only four alive, and their leaves show crabby characteristics. Twenty-four of the number were Anisim seedlings, all root-killed; the tops of some started, but the wood was badly discolored in all; three were saved for transplanting, but none survived. Seven of these Anisim seedlings were given numbers in August, 1898, and top-budded into young orchard trees of Hibernial, with a view to early fruiting. These buds united well, and all started in the spring of 1899. But our hopes were in vain, because the young Hibernial trees were all root-killed.

In the spring of 1897, three hundred one-year seedlings, grown from seed saved in the orchard of the Iowa Agricultural College, all from Antonovka, were received from that station and planted. They made a strong growth and came through the first winter in perfect condition. But the winter of 1898-99 root-killed every one. Forty-one of these trees were saved for transplanting, as the buds started well,

and the wood, although hurt, was not as badly discolored as the others; but not one survived the summer.

These two experiments were not intended to test the value of hardy varieties for stocks, as it was my purpose to save them for fruiting with the hope of obtaining some valuable varieties, but they certainly indicate that seedlings from varieties of the grade of hardness of Anisim and Antonovka, are not sufficiently hardy for stocks in this section.

### BUDDING VS. PIECE-ROOT GRAFTING.

In the nurseries of Europe piece-root-grafting in winter is not practiced, budding in August at the collar on seedlings already established in nursery being the accepted method. Grafting at the collar in the spring is used where the bud has failed. These two methods are the only ones that give the strong, straight-stemmed trees demanded by their trade. The apple trees noted by the writer in 1894 in visiting many nurseries and schools of horticulture in a four months' trip\* through England, Germany, Denmark, Sweden, Russia, Austria, Belgium and France were all propagated in this manner (except those in northern Russia) and impressed me with their smooth, healthy and vigorous growth. A two-year budded tree averaged fully as large as a three-year-old piece-root-grafted tree in our western nurseries and were superior in smoothness of stem and freedom from an undue number of pruning scars.

Indeed, our American nurserymen in the eastern states have long practiced the budding of apple trees, the same as in European nurseries, as they find it gives a larger percentage of saleable trees. Western apple seedling growers meet this eastern demand for seedlings with branched roots, by sorting these out (called "budders" in nursery parlance). These "one year No. 1 seedlings, 3-16 inch and up at the collar," with branched roots are worth as much wholesale as those with long, straight unbranched roots of the same cal-

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\*Iowa State Horticultural Society report 1894, p. 149; 1895, p. 453.  
Minnesota State Horticultural Society report 1896, p. 498.



iber at the collar which are used for piece-root-grafting. In European nurseries the branched roots are obtained either by crowding the seedlings in seed-bed the first year and transplanting with trimmed roots the second year; or more commonly by transplanting the seedling the first year when quite small. This latter method is called "pikiren" by German growers, and is practiced extensively in French and German nurseries. This transplanting (and root pinching) breaks up the tap root and causes it to branch.

The budded trees of eastern nurseries have failed in the Northwest because of the seedling root being too near the surface. Northwestern nurserymen have found piece-root grafts far better because by using a long scion and short root the tender seedling is brought several inches deeper below the surface and the scion has an opportunity to form its own roots. "Whole-root-grafted trees" are exposed to the same danger as budded trees, the tender seedling being brought too near the surface. If made with as long a scion as the piece-root grafted trees, the seedling root has the same chance of protection by the earth covering, and the scion roots have the same opportunity to form roots. But this is not usually done as it would make the root-graft too long for convenient planting in the nursery. But last winter's experience at Brookings demonstrates that the scion roots of hardy varieties of the cultivated apple are tender as well as the seedling roots, so that hardier stocks are necessary on the northern borders of orcharding in the prairie Northwest.

The latest reference on the subject we find as this bulletin goes to press. Geo. J. Kellogg of Janesville, Wis., writes in *Wisconsin Agriculturist*, September 7, 1899:

"After last winter's experience we need a root for the apple as hardy as the crab root, and while I fully believe in using crab seed for stock the trials made thirty years ago on such stock tended to dwarf the trees and bring them into earlier bearing, owing to lack of vigor and push, but such stocks certainly are more hardy in the root, and if we can secure Virginia crab seed I think they will make the best stocks we can get...."

At Brookings we find Virginia crab, standing next to Transcendent in the old Station orchard, planted in 1888, blighting badly the past two years; the foliage, also, is subject to scab. This variety has not blighted in the young Station orchard, planted in 1896, with no Transcendent near, and these young trees proved hardy the past winter.

### THE PROBLEM BEFORE US.

It now remains to be settled by experiment which is the best form, if any, of the Siberian crab to use for stocks. Judging from the foregoing notes and from numerous inquiries made while in Russia, the writer is inclined to consider *Pyrus baccata* as the best for our use. It is the hardiest known species of the apple, and the influence of hybridity will not come in as a disturbing factor in ascertaining results. Seed from Siberia is not yet obtainable in commercial quantities, but with the opening of the new Siberian railway this difficulty will soon be obviated. Just east of Lake Baikal, *Pyrus baccata* is said to occur in such abundance that a certain range of mountains is called "Apple Mountains." The writer is endeavoring at present to obtain more seed from this region.

The Transcendant and Hyslop crabs blight so badly at Brookings as to be worthless. The old Yellow or Red Siberian, with fruit the size of a cherry, or less, may prove very useful, also the old Cherry crab; old trees, forty years old or more, are found scattered through the older parts of the West, and at present are neglected because of small size of fruit. The seed of all crabs with deciduous calyx, such as the old Yellow Siberian, should be saved. Mr. Gideon's plan should also be carefully tested of saving seed from hardy hybrid Siberian crabs.

As a matter of fact, it appears that the question of hardier stocks has not forced itself upon public notice save after unusually severe winters, where much loss was experienced from root-killing. In ordinary seasons it was found that the common apple seedlings were more readily obtainable in commercial quantities, and the losses from root-killing passed

gradually from memory. Had the "test winters" occurred every winter, it is probable that the crab stock question would have received more general attention. For the northern part of South Dakota the liability to root-killing is greater than in regions in the same latitude with greater snowfall further east, and the need of a hardy stock becomes more manifest. It is the purpose of this bulletin to call attention to the matter, and to stimulate exact experimentation along this line, rather than to make positive recommendations.

From the evidence at hand it appears that no piece-root-grafting will avail. No roots from the scion should be permitted. The stocks for a fair test should be handled much like the Mahaleb or Mazzard stocks for the cherry in the Eastern nurseries, setting the stocks in nursery first, and afterwards, when established, budding the cultivated apples upon them. Perhaps both hybrids and pure Siberian seedlings will prove too much subject to blight for the method to be successful in all localities. But certain it is, that the present method of growing apple trees on French crab or Vermont cider apple seedlings will not do for a considerable area of the Northwest in test winters.

It will take many experiments to fully settle the question. Let all who can try a few and report results. In the meantime, we strongly advise watering trees if possible before the ground freezes in the fall, and then applying a heavy mulch also before the ground freezes, to prevent too severe freezing of the roots.

### SUMMARY.

1. By the word "stock", nurserymen mean the tree or root upon which a tree is grafted or budded.

2. The ordinary American and French apple seedlings (*Pyrus Malus*) now used as stocks for the cultivated apple, are not sufficiently hardy over a large part of the prairie Northwest in severe winters. This causes root-killing, and the hardy top, thus left without a root to support it, necessarily perishes.

3. The American wild crab (*Pyrus Ioensis*) as found native at Des Moines, Iowa, winter-killed at this station, and hence is not sufficiently hardy to use as a stock. It has not been found native in South Dakota, save in the southeastern corner.

4. The experiments at this station show, that the roots thrown out from the scion in root-grafts of the hardy varieties of the cultivated apple are hardy in ordinary winters, but did



not prove hardy the past severe winter (1898-'99), minimum temperature forty degrees below zero Fahrenheit with the ground bare.

5. Limited experience with seedlings of hardy varieties of the cultivated apple at this station, indicates that they will not be exempt from root-killing in winters like that of 1898-'99. Seedlings of the wild apple from the province of Kursk, southern Russia, also proved subject to root-killing.

6. Top-grafting on Siberian crabs has not proved generally successful. Piece-root-grafting on Siberian crab seedlings has not proven successful as tried by a number of Northwestern nurserymen.

7. The commercial methods of propagating apple trees in American and European nurseries are described. In the nurseries of Europe and the Eastern United States, budding upon seedlings previously planted in the nursery is preferred to piece-root-grafting in winter. In the Western nurseries piece-root-grafting with a long scion and short root is the better method, as it puts the tender seedling root further beneath the surface.

8. The true Siberian crab (*Pyrus baccata*) is the hardiest known species of the apple and if it proves sufficiently exempt from blight, may prove of great value as a stock in sections where root-killing is a source of trouble. Young plants of this species proved perfectly hardy the past winter on the grounds of this station.

9. Translations from Russian authorities are given to aid in distinguishing *Pyrus baccata* from other closely related crabs.

10. A root-graft of *Pyrus baccata odorata* upon the station grounds lost the American seedling root by winter-killing, but the tree was saved by the root thrown out by the scion, which proved hardy.

11. The Russian method of preventing root-killing by using the true Siberian crab (*Pyrus baccata*) as a stock, is described.

The Russian experience with this species as a stock is that it causes earlier bearing, but dwarfs the tree somewhat in growth. In sections where root-killing is a source of frequent trouble, this Russian method deserves a trial.

12. Until the question of hardy stocks is settled, trees should be well mulched every fall before the ground freezes, to prevent too deep freezing of the roots and consequent winter-killing.