
UNIVERSITY OF MINNESOTA.

EXPERIMENT STATION

OF THE

COLLEGE OF AGRICULTURE,

ST. ANTHONY PARK, RAMSEY CO., MINN.

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BULLETIN No. 3.

HORTICULTURE.

INTRODUCTORY—OUR RUSSIAN APPLES AT THE OPENING OF
THEIR FOURTH SEASON. NURSERY STOCK—NATURAL
AND ARTIFICIAL FERTILIZATION OF PLANTS.

ENTOMOLOGY.

REPORT ON THE ROCKY MOUNTAIN LOCUSTS IN OTTER TAIL
Co., MINN., IN 1888.

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INTRODUCTORY.

In carrying out the objects of the organization of an "Agricultural Experiment Station," we cordially invite the co-operation of all persons interested in its success. Suggestions as to lines of experimental work, problems to be solved, inquiries relating to agriculture, horticulture, stock, and the dairy, will be cheerfully received, and answered as far as possible; but no work will be undertaken unless of public value, and the results of which we are at liberty to use for the public good.

Specimens of grains and grasses; seeds of fruit and forest trees; vegetables, plants, and flowers that are true to name; varieties of beneficial and injurious insects; samples of mineral waters and ores, and whatever may illustrate any department of agriculture will be gladly received, and due acknowledgments made in annual reports. Directions for collecting, packing and shipping such specimens will be furnished on application, and all expenses paid.

Bulletins will be issued at least quarterly, giving the results of experimental work as fast as completed, together with such suggestions and information as may be thought valuable to the farmers of Minnesota.

The Bulletins and reports of this Station are sent free to every citizen of Minnesota who applies for them. Copies are sent as soon as issued to every newspaper in the State, to every Grange, Farmers Alliance, or other Agricultural Organization, whose addresses can be obtained. Bulletins and reports are also sent to the leading Agricultural papers of the country, and will be sent to any paper that may desire to exchange.

Letters relating to any special line of work should be directed to the officer in charge of that division, but all general correspondence relating to the work of the Station should be addressed to

EDWARD D. PORTER,
Director of Experiment Station.

St. Anthony Park, Ramsey County, Minnesota.

DIVISION OF HORTICULTURE.

SAMUEL B. GREEN.

*To the Farmers and Horticulturists and Friends of Horticulture
in the State of Minnesota, and Citizens generally.*

In presenting the first bulletin from your horticultural department of the experiment station, of which I have the honor to be in charge, I am desirous to have it distinctly understood that I consider myself your servant, and am anxious to carry out your wishes. I want to get close down to the work and make this a practical, working department, of service to you.

It ought to be, and shall be, with your permission, a help to you. I want to know your wishes, and knowing them shall act accordingly to the best of my ability and power to perform.

An experiment station in this country is but a thing of to-day. It has just started on its career. In France, England, Germany, Sweden, Norway, Holland, Belgium and Denmark experiment stations are as much an establishment as any other institution of the government. These governments have been forced by the increase of their peoples, and the necessity for close cultivation, to see the vast benefits coming from an intelligent system of agriculture.

The experiment stations in this country have come to stay. They were created to supply a demand and a want.

The intelligent farmers and legislators of the country know, full well, that from the cultivators of the soil comes the greater part of the wealth of the nation, and that it is for the best interests of the nation that every means be employed to stimulate agricultural thought and inquiry. For this purpose, the agricultural schools and stations were established.

As an experimentalist and horticulturist, I do not expect to perform miracles. But I do expect, by careful observing and trying, and working, and judiciously carrying out your ideas and comparing one season with another, to develop and extend methods in the interest of economy and comfort. This season,

I work to disadvantage; having only arrived at my post the first of the past April. I am as yet ignorant of your needs and wishes. I trust that so soon as may be practicable, you will through your societies or by any means, which seem to you best, formulate your wishes and expectations, and inform me of the same at the earliest possible moment.

It has been necessary, in order to have the work done at the proper time, for me to take the initiative in organizing and commencing the experiments for this season, and I have decided upon, and commenced the following lines of work, with a view to-1st, discovering new valuable varieties in vegetables and fruits; 2d, discovering new values in old varieties of vegetables and fruits; 3d, with a view of discovering and discarding from our fruit, vegetable and forest tree lists, worthless varieties, and making out lists in each department suited for the needs of the market garden, the farm, or the farmer's garden of the Northwest; 4th, with a view of protecting the farmers from fraud by discovering and announcing the fact when an old variety is offered for a new at a high price or a worthless variety is offered as a desirable novelty; 4th, discovering improved methods of cultivating the soil. With these purposes in view, I have commenced observations on 200 varieties of Russian apples, pears, plums and other promising varieties of fruit, of which we had or could obtain a supply. Have added to our stock on hand so that we have some 50 varieties of strawberries, 30 varieties of raspberries, 20 varieties of blackberries and dewberries, 12 varieties of our native plums, 50 varieties of grapes, etc. Besides these, we have many promising varieties of huckleberries, gooseberries, juneberries and sand cherries.

In the line of vegetables have planted about 800 kinds and varieties. We have a small collection of forest and ornamental trees for observation and experiment, the most of which are known to be of some economic value. Have also commenced experiments as follows:

1st. With a view of determining the best depth to plant and the best methods of cutting potatoes for planting. Have also planted tubers of every promising variety of potatoes for the purpose of thoroughly trying their merits.

2d. With a view of determining the most desirable amount of onion seed to sow, per running foot of row, and the least dis-

tance which they can be grown apart to produce the largest crop on the smallest space with a minimum amount of labor.

3d. With a view of trying in field culture the relative merits of the cabbage crop from seeds sown in the hill and transplanted plants.

4th. With a view of ascertaining the best method of raising stock beets, and rutabaga turnips, that are free from side roots.

5th. To ascertain the best and most economical method of blanching celery, in the conducting of which I have in mind the best flavored flesh and the neatest appearance, together with an economical method.

6th. With a view to determine the best method of pruning and caring for grape-vines in the Northwest, where the vines must be covered on the approach of winter.

7th. To determine how much the ripening of grapes may be hastened by careful girdling of the canes; and the effect on the vine.

8th. To determine the influence, if any, which the grafting of grapes may have on the fruit. Having in view the hastening of the period of ripening and the increase of vigor in weak-growing varieties.

9th. Have commenced experiments to determine the advantage, if any, of Northern over Southern and California-grown seed.

10th. Have made sowings of potato seed, with the purpose of originating new varieties.

11th. To determine value of the different insecticides offered in the market.

12th. To determine the best methods of fertilization and the best fertilizers for garden crops. Only such fertilizers being used as are, or soon will be, accessible to the farmers of Minnesota.

I am anxious to obtain from any source, varieties of promising usefulness, and will agree not to propagate for distribution, whenever the introducer may so request. And I further guarantee that every variety so presented shall have a fair and careful trial, and that an exact statement will be made of its qualifications for the purposes proposed by the introducer, and its qualifications for any other known purpose. Such conclusions will be published in our bulletin for the benefit of the public.

THE RUSSIAN ORCHARD.

This was planted in the spring of 1885 to demonstrate how far the Russian apples are adapted to the climate of Minnesota.

The nursery is located on the open prairie in a very rich soil.

The original plantation consisted of 130 trees, embracing 65 varieties of Russian apples. Fifty-two Duchess trees were also planted to afford a basis of comparison. These trees have been replaced by new varieties, whenever they have proved themselves too tender for the conditions imposed.

The following remarks will serve to make clear the tables annexed:

The observations have been made at various periods of growth.

Those for 1888 were made the middle of May, when about all the Russian apple buds were bursting, although the Duchess had but just started, and again the 10th of June.

The height given is from the soil line to the top of the new growth. From this can be judged the amount of exposure above the snow line.

In considering the names of our Russian fruits, it will be remembered that until the publication of the authoritative lists of the American Pomological Society in 1887 they were confused, and that there were many synoyms. This resulted from there being several importations, and from the fact that each importer rendered the Russian into English as well as practicable.

This was necessary for euphony and abbreviation.

The names for our Russian fruits, as recommended by the American Pomological Society, will undoubtedly become the standard and be generally adopted.

In the first column of the table will be found numbers and abbreviations.

When the numbers alone are used, they refer to the importation made by the Department of Agriculture in 1870. M following a number refers to the importation received at Ames, Iowa, from Moscow in 1879.

Vor refers to the importation from Voronesh.

Orel " " " " that place.

Riga " " " " " "

Some varieties are known only by number, the name being

lost. Some are known by name and have no number. The second column contains the name under which they have been sent out from this station. The third column contains the name recommended by the American Pomological Society.

All the trees made a fine growth the first season.

In the following table report is made of the strongest tree of each kind considered.

Number.	Name by which they have been or are known.	Names as revised by the Committee of the American Pomological Society.	GROWTH.			When Planted. If dead, the winter when they died.	No. of Trees originally planted.	No. of Trees that are now alive.	Present height of Trees.	CONDITION OF TREES AFTER THE WINTER OF		
			1885.	1886.	1887.					1885-6.	1886-7.	1887-8.
230	Titus	Titovka				1886	1	1	3 feet			
599	Romna or Omensk.	Romeneskoe	Good..	Fair	24 in.	1885	2	1	4 feet	Fair	New wood killed badly	Killed back 6 inches.
138M	Borovinka	Borovinka	Good..	Good	24 in.	1885	2	2	4½ feet	Good	New wood dead	Almost perfect.
88M	Gruchevka	Pear	Good..	Good	16 in.	1885	2	2	4½ feet	Good	Good	Killed back 4 inches.
1277R	Rosy Veronesh		Good..		1885-6					Good	Good	Almost perfect.
24M	Sandy Glass	Sandy Glass			27 in.	1886						
477	Christ Birth	Christmas	Good..	Good	31 in.	1885-6	2	1	3 feet	Poor	Killed to snow line	Killed back 5 inches.
413	Cross	Cross	Good..	Poor	20 in.	1885-6	2	1	2½ feet	Fair	Killed to snow line	Killed back 2 inches.
269	O'Porto Rosy	Rosy Aport	Good..	Poor	24 in.	1886	1	1	3 feet	Poor	Killed back 6 inches	Killed back 1 inch.
334	Yellow Transparent	Yellow Transparent	Good..	Good	21 in.	1885	2	2	3 feet	Good	Killed back to s'w line	Killed back 6 inches.
268	Saccharine	Zakoritnoe	Good..		27 in.	1886	1	1	3½ feet		Killed back to old wood	Killed back 1 inch.
202	Hare Pipka	Hare Pipka	Good..		26 in.	1885-6	2	1	3½ feet	Fair	Killed to old wood	Killed back 1 inch.
200	Red Repka	Repka	Good..		17 in.	1885	2	2	5½ feet	Fair	Killed back 1 inch	Killed back 1 inch.
315	Lord's Herrenapfel	Herren	Good..		22 in.	1886	1	1	3½ feet		Killed back 1 inch	Almost perfect.
882	Green Butskaya	Russian Green	Good..	Poor	22 in.	1885-6	2	1	5 feet			Killed back 3 inches.
4M	Ostrakoff's Glass	Ostrakoff	Good..	Good	26 in.	1886-6	1	1	4¾ feet			Killed back 1 inch
109 Vor	Aport Orient	Juicy Rubets	Good..	Good	24 in.	1885	2	2	5½ feet	Good	Killed back 4 inches	Killed back 2 inches.
	Rubets Nativ	Cinnamon Pine	Good..	Poor	22 in.	1885	2	2	5½ feet	Good	Killed back 1 inch	Almost perfect.
375	Browny Pine	Kremer's Glassy	Good..	Poor	22 in.	1885	2	2	5½ feet	Fair	Killed back 4 inches	Very good.
284	Kremer's Glassy	Kremer's Glass	Good..	Good	21 in.	1886	2	2	5¾ feet	Fair	Most of new w'd killed	Killed back 3 inches.
447	Kiev Reinette	Kiev Reinette	Good..	Good	18 in.	1885	2	2	3¾ feet	Fair	Most of new w'd killed	Killed back 4 inches.
277	Wargul	Vargul	Good..		14 in.	1885	2	2	3¾ feet			Killed back 1 inch
206	Czar's Thorn	Czar's Thorn	Good..		30 in.	1885-6	2	1	4 feet	Fair	K'd b'k into old g'wth	Killed back 6 inches.
210	Vinograd	Wine Rubets	Good..		18 in.	1886				Fair	Killed back 10 inches	Killed back 6 inches.
489	Grandmother	Grandmother	Good..		22 in.	1886	2	2	5 feet		Killed back 4 inches	Good.
407	Blackwood		Good..	Weak	w.sp. 30	1885	2	2	2½ feet	Good..	Bad	Killed back 2 inches.
177	Green Streaked	Green Streaked	Good..	Good	8-18 in.	1885-8	2	1	7 feet	Good..	Good	Killed back 3 inches.
934	White Aport	White Aport	Good..	Fair	16 in.	1885	2	2	4 feet	Good..	Good	Very good.
105	Russian Gravenstein	Russian Gravenstein	Good..	Fair	20 in.	1885-6	2	1	4½ feet	Fair	All new wood dead	Only termin'l b'ds k'ed
475	Holdfast	Shepherd				1886				Fair	Killed back 6 inches	4 inches of wood dead.
	Sklanka Bog		Good..		20 in.	1886	1	1	2½ feet			Weak.
	Sunbrick		Good..		20 in.	1886	1	1	3 feet			Killed back 4 inches.
457	Klineff or Klineff's Apple	Kluevskoe	Good..	Good	20 in.	1885	2	2	5½ feet	Good..	Most of new wood dead	Killed back 4 inches.
185	Anisette	Anisovka	Good..	Fair	22 in.	1885-6	2	1	4½ feet	Fair	Most of new wood dead	Very good.
187	Glass Green	Green Glass	Good..	Fair	18-30 in.	1885	2	2	4½ feet	Fair	All new wood dead	Killed back 4 inches.
												Terminal buds dead.

31M	Dobruia Krestiana	Good Peasant	Good	12-50 in.	1885	1885-6	2	1	4	feet	Fair ..	Killed back badly	4 inches of tips dead.	
282	Woronech's	Voronezh Reinette	Good	Weak	18 in.	1885	1885-6	2	1	4	feet	Fair ..	Killed slightly	2 inches of tips dead.
181	Champagne Pipka	Champagne Pipka	Good	24 in.	1886		1	1	3½ feet		Good ..		4 inches of tips dead.	
161	English Pippin Longfield	Longfield	Good	22 in.	1885	1885-6	1	1	3½ feet	Fair ..	Killed back to old w'd		4 inches of tips injured	
316	Red Queen	Red Reinette	Poor	23 in.	1885	1885-6	2	1	2½ feet		Poor ..		4 inches of tips dead.	
365			Good	24 in.	1886		1	1	3½ feet				2 inches of tips dead.	
38Vor	Fiat Voronesh	Rambour Reinette	Good	15 in.	1886		1	1	2 feet		Good ..		1 inch of tips dead.	
502	Bamboor Queen	Rambour Reinette	Good	22 in.	1885	1885-6	2	1	4 feet	Fair ..	Killed back badly		Killed back 2 inches.	
236	Antinovka	Antonovka	Good	24 in.	1885		2	2	3 feet	Good ..	Killed badly		Killed back 2 inches.	
252	Aport	Aport	Good	24 in.	1885	1885-6	2	1	3 feet	Fair ..	Killed back to old w'd		Killed back 2 inches.	
262	Charlamoff	Charlamoff	Good	Fair	22 in.	1885	1885-6	2	1	3 feet	Fair ..	Killed back to old w'd		Term'l b'ds only dead
323	Repovka	Riepovka	Good	22 in.	1885		1	1	2 feet				Terminal buds dead.	
361	Pointed Pipka	Pointed Pipka	Good	Good	22 in.	1885		2	2	6 feet	Good ..	Very good		Very good.
246	Plodovitka	Prolific	Good	1885			2	1						
984	Koursk Anis	Knrsk Anis	Good	Good	28 in.	1885	1885-6	2	1	5 feet	Fair ..	Good ..		Killed back 3 inches.
203	Arcad	Arcad	Good	Good	14 in.	1885	1886-7	2	1	5 feet	Good ..	Killed back 1 inch		Almost perfect.
21Vor	Yellow Calville	Heidhorn	Good	Good	28 in.	1885		2	2	6 feet	Good ..	Killed back 1 inch		Almost perfect.
164	Heidhorn	Heidhorn	Good	Good	15 in.	1886		1	1	3 feet		Killed back 1 inch		Killed back 4 inches.
58Vor	Gipsy Girl		Good	Fair	10 in.	1885	1885-6	2	1	3½ feet	Fair ..	Killed only term'l b'ds		Killed back 2 inches.
45Vor	Early Sweet Veronesh		Good	Weak	10 in.	1885	1887-8	2	1	3 feet	Fair ..	Killed back 4 inches		Killed back 2 inches.
878	Hibernal	Hibernal	Good	Good	12 in.	1886		1	1	3 feet		Good ..		Killed back 1 inch.
214	Garden	Garden	Good	Good	1886								Poor.	
904	Switzer	Switzer	Good	Good	20 in.	1886		1	1	3½ feet		Killed back 6 inches		Killed back 1 inch.
4M	Ostrakoff's Glass	Ostrakoff	Good	Good	6 in.	1885		2	2	4½ feet	Fair ..	Killed back 1 inch		Killed back 1 inch.
29M	Melonen	Melonen	Good	Good	18 in.	1886		2	2	2½ feet				Killed back 1 inch.
20M	Koursk Reinette	Kursk Reinette	Good	Good	12 in.	1885		2	2	4½ feet	Fair ..	Killed back 4 inches		Killed back 1 inch.
22M	Blushed Calville	Blushed Calville	Good	Good	19 in.	1885		2	2	4¾ feet	Good ..	Killed back 1 inch		Almost perfect.
984	Koursk Anis	Kursk Anis	Good	Good	20 in.	1886		1	1	3½ feet		Killed back 2 inches		Killed back 2 inches.
282	Woronech's	Voronezh Reinette	Good	Good	15 in.	1886				3½ feet		Killed back 2 inches		Wintered well.
243	Thorne				8 in.	1886				2 feet				In good order.
290	Ukraine	Ukraine			30 in.	1886		1	1	3½ feet				Killed back 1 inch.
*Duchess of Oldenburg														
			Good				52	27					Killed back about 6 in.	

*Many of the remaining trees are almost worthless.

REMARKS.

33 trees died in the winter of 1885-86.

7 "	"	"	"	1886-87.
29 "	"	"	"	1887-88.

Of the trees originally planted, fifty per cent. of the Russian are alive; many of them in a very promising condition. Of the Duchess originally planted, fifty per cent. are still alive, but most of them are very weak and poor.

It is fair to suppose that where two trees of a kind are dead, that the tree is, at least, of very doubtful hardiness.

It is quite probable that some of our Russians, as they mature, will become hardier.

The following varieties are the most promising in our orchard:

177 Green Streaked.	83 Pear.	210 Wine Rubets.
457 Kleurskoe.	200 Red Repka.	203 Arcad.
187 Green Glass.	Aport Orient.	21 Vor. Yellow Calville.
361 Pointed Pipka.	109 Vor.	22 M. Blushed Calville.
599 Romenskoe.	447 Keiv Reinette.	984 Koursk Anis.
282 Voronezh Reinette.		

CONCLUSIONS.

That while many of our Russians have died, yet there are many remaining which are very promising, and 16 which would be called good trees in any orchard. From this experiment we have found 16 varieties out of 65, or 24 per cent. of those planted, which have withstood this severe climate for three years, with very little or no killing, and very many others that have done better than the Duchess. It seems to me from careful observations that we have much to hope from our Russian apples.

CONDITION OF TREES, SHRUBS AND VINES IN THE NURSERY AFTER THE WINTER OF 1887-88.

These notes were made the last of May. The nursery in which they grew is somewhat protected.

In the following list the first name and number is the one under which it was received by us, and by which we have designated them, when sending out our packages for distribution and trial; the second, that adopted by the American Pomological Society:

PEARS.

102 *Vor. Bessemianka*; *Seedless*. Has wintered perfectly and starts vigorously. Growth 20 inches.

27 *R.* All but terminal buds very vigorous. Growth from 15 to 36 inches. Height of tree, $4\frac{1}{2}$ ft.

508 *Bessemianka*; *Seedless*. Has wintered perfectly. Growth from 8 to 18 inches. Fine, healthy trees, 5 ft. high.

16 *Orel*; *Waxen*. Has wintered very well. Growth from 18 to 20 inches. Healthy tree, 5 ft. high.

APPLES.

Giant Swaar. Has wintered perfectly. Growth 8 to 15 inches. Height 7 ft. Fine, healthy tree.

Early Strawberry Crab. Wintered perfectly. Growth 12 to 18 inches. Height $7\frac{1}{2}$ ft.

Minnesota Crab. Wintered perfectly. Growth 8 to 24 inches. Height 7 ft. Full of blossoms this spring.

Powers Crab. Wintered perfectly. Growth from 12 inches to 2 ft. Height 7 ft. Full of blossoms this spring.

Pearce's Crab. Most of terminal buds dead. Growth 8 inches to 2 ft. Height 6 ft.

Beecher's Sweet Crab. Has wintered perfectly. Growth from 1 to 2 ft. Height 6 ft.

Orange Crab. Wintered perfectly. Growth 8 inches to 2 ft. Height 7 ft.

Duchess. Killed back 8 inches. Growth 18 inches. Height 7 ft. Weak.

Wealthy. Killed back most of new growth. The trees of this variety seem to be weakened by the winter.

Tetofsky. Killed backed 2 inches. Growth 8 to 24 inches. Height 5 ft.

Whitney's No 20. Wintered perfectly. Growth from 12 to 18 inches. Height $7\frac{1}{2}$ ft.

Rollin's Pippin. Killed back 6 to 8 inches. Growth 30 inches. Height 4½ ft.

PLUMS.

Miner. This large, well known, standard plum, has come through the winter with very little injury and blossomed fully. Growth 3 ft. Height 7 ft.

Rolling Stone. Had most of its terminal buds killed. Growth from 12 to 30 inches. Height 8 ft. Tree vigorous and full of blossoms.

De Soto. Terminal buds killed. Tree vigorous. Growth 1 to 4 ft. Height 8 ft. Full of blossoms.

Forest Garden. Wintered perfectly. Growth 12 to 30 inches. Height 9 ft. Tree vigorous and full of blossoms.

Weaver Plum. Wintered perfectly. Growth 1 to 3 ft. Height 8 ft. Tree vigorous and full of blossoms.

RASPBERRIES.

All our raspberries were pruned in the fall, laid on the ground, and covered with about four inches of soil. They were lifted May 17th, when the buds were an inch long, and we thought settled weather was assured. They have most of them wintered very well, and the outlook for fruit is promising.

Golden Cap. This is a very distinct cap variety, with very yellow fruit and bark, and light foliage, which makes it ornamental and distinct. The fruit the past season has proven excellent for desert purposes. It has wintered very well.

Schaffer's Colossal. Seems to be a very prolific, strong grower, and desirable for home use and a near market wherever grown. Produced a good crop of fruit last year, and has come through the past two winters perfectly.

Cuthbert. This berry has withstood the past three winters perfectly. It is a strong grower, with large, fine, sweet, dark crimson fruit, which has good keeping qualities. Its season is very late. It is the most desirable red raspberry for general use.

Turner. Has withstood the past three winters perfectly. It is a strong grower and fruitful. Has large, sweet, crimson berries, and is very desirable for the home garden. It is a little too soft for market purposes.

Marlboro. Has withstood the past two winters perfectly. It is vigorous and productive. The fruit is large and of a bright crimson color. A good shipping berry and of fair quality. The

season is very early, which makes it desirable. It is not so good as the Cuthbert for any purpose, except an early crop.

BLACKBERRIES.

They were covered in the fall the same as raspberries.

Ancient Briton. Has wintered well. It is a good, strong, growing variety. Somewhat injured by bending when covered in the fall.

Stone's Hardy. This is a hardy, desirable variety. Has wintered very well.

Snyder. An excellent, hardy variety. Some canes not covered last fall, standing four feet high, have come through the past winter perfectly, when we had a recorded temperature of 50° below zero. Our buried ones do not look so well as those left exposed.

CURRENTS AND GOOSEBERRIES.

These plants are located in the nursery with an exposure to the north and northwest. They are large, strong bushes, and have had no protection, except the snows of winter, since first planted.

Currants.

Red Dutch. These have wintered perfectly and promise an abundant crop of fruit.

Black Naples. Is in the very best condition and promises an abundant crop of fruit.

Fay's Prolific. This variety is full hardy enough for this climate and promises to fruit with us for the first time.

Stewart's Seedling. This is recommended as the best currant for the Northwest. Prolific and hardy.

Gooseberries.

Downing Gooseberry. Is in perfect condition this spring and full of fruit blooms.

STRAWBERRIES.

Our beds were not covered with any protecting material except the snow which naturally fell upon them. They are situated on the northeast slope of a hill and so have thorough drainage, which is very essential in the successful wintering of this fruit.

Iron Clad. A perfect flowering variety. A good berry and fair grower. Has wintered perfectly.

Minnetonka Chief. This is a native, pistillate berry, firm-

fleshed of good size and sprightly flavor. Prolific and vigorous; very late in ripening. It has wintered perfectly.

Manchester. A pistillate variety, of good size, flavor and color, and a fair cropper. Is 2nd early. The fruit is inclined to become very soft in wet weather. It has wintered perfectly.

Chas. Downing. An old variety, and where it can be grown well it is still very desirable for the near market and for home use. It is liable to rust of the leaves. With us, they have wintered well, but have shown more or less signs of rust.

Crescent. This is a pistillate berry, very popular in this state. It is a very desirable berry on account of its producing abundant crops, its earliness in ripening, and its bright crimson color. Has wintered perfectly.

Ray's Prolific. This pistillate variety has been grown three years on the station lands, and it has proved prolific of nothing but runners and blossoms, and is useless for the fruit garden. It has had every chance of being fertilized by strong pistillate varieties like the Iron Clad, but it has not produced respectable fruit.

MULBERRY.

Russian Mulberry. Was transplanted last spring. As they were severely cut back at the time, they made a succulent growth, and, consequently, the trial was not a fair one for them. Killed back from 3 to 6 inches. Growth 2 feet. Grown in form of a hedge $2\frac{1}{2}$ ft. high.

BARBERRIES.

Planted last spring. Growth 2 ft. Killed back 4 inches. Grown in form of a hedge $2\frac{1}{2}$ ft. high. Vigorous and promising.

The following List of evergreens have withstood the winter perfectly:

BOTANICAL NAME.	HEIGHT.	COMMON NAME.
<i>Abies Concolor</i>	2 ft.	
<i>Abies Englemanii</i>	2 ft.	Engleman's Spruce.
<i>Picea Pungens</i>	2 ft.	Colorado Spruce.
<i>Pinus Austriaca</i>	2 ft.	Austrian Pine.
<i>Pinus Sylvestris</i>	3 ft.	Scotch Pine.
<i>Pinus Resinosa</i>		
<i>Pinus Strobus</i>	2 ft.	White Pine.
<i>Abies Excelsa</i>	2 ft.	Norway Spruce.
<i>Abies Alba</i>	$1\frac{1}{2}$ ft.	White or Blue Spruce.
<i>Abies Balsamea</i>	$2\frac{1}{2}$ ft.	Balsam Fir.
<i>Tsuga Canadensis</i>	$2\frac{1}{2}$ ft.	Hemlock Spruce.
<i>Thuja Occidentalis</i>	$1\frac{1}{2}$ ft.	Arbor Vitæ; Red Cedar.

The following table will show the condition of Russian and other shrubs and trees that have stood the past year in the nursery, exposed to the north and northwest winds. Height refers to distance from soil level to top of new wood.

COMMON NAME.	BOTANICAL NAME.	REMARKS.	Heig't.
Napoleon's Willow	Salix Napoleonensis	Wintered perfectly.....	4 feet
Russian Golden Willow	Salix Aurenni.....	Wintered perfectly.....	4 feet
Riga 31 Willow	Salix.....	Wintered perfectly.....	4 feet
Red Willow	Salix Fragilis.....	Wintered perfectly.....	4 feet
Laurel-leaved Willow	Salix Laurifolia.....	Wintered perfectly.....	4 feet
14 Vor. Willow	.....	.....	4 feet
127 Vor.	.....	Wintered perfectly.....	4 feet
European White Birch	Betula Alba.....	Wintered perfectly..... Vigorous—Killed back from 6 to 10 inches on shoots 4 feet long.....	7 feet
Catalpa	Catalpa Speciosa.....	.....	12 feet
Alder	Alnus Incana.....	Wintered perfectly.....	8 feet
Mountain Ash	Pyrus Americana.....	Wintered perfectly.....	9 feet
Tamarack	Larix Americana.....	Wintered perfectly.....	5 feet
European Larch	Larix Europea.....	Wintered perfectly..... Killed back from 1 to 2 feet on new wood 3 feet long.	4 feet
Black Walnut	Juglans Nigra.....	Perfectly hardy.....	5 feet
Wild Cherry	Prunus Serotina.....	Perfectly hardy.....	9 feet
Norway Maple	Acer Platanoides.....	Perfectly hardy.....	5 feet
Box Elder	Negundo Aceroider.....	Perfectly hardy.....	9 feet
Green Ash	Fraxinus Veridis.....	Perfectly hardy.....	9 feet
White Ash	Fraxinus Americana.....	Perfectly hardy.....	9 feet
.....	Populus Certinensis.....	Perfectly hardy.....	15 feet
.....	Populus Petrovsky.....	Perfectly hardy.....	12 feet
Laurel-leaved Poplar	Populus Laurifolia.....	Perfectly hardy.....	12 feet
Siberica Poplar	Populus Siberica.....	Perfectly hardy.....	12 feet
White Poplar	Populus Alba.....	Perfectly hardy.....	12 feet
23 Riga Poplar	.....	Perfectly hardy.....	12 feet
116 Vor. Poplar	.....	Perfectly hardy.....	12 feet
*	Populus Bolleana.....	Perfectly hardy.....	12 feet
15 Vor.	Populus Fastigata Pyramidalis.....	Perfectly hardy.....	12 feet
.....	Spirea Nobleana.....	Perfectly hardy.....	4 feet
.....	Spirea Amurensis.....	Perfectly hardy.....	4 feet
.....	Spirea Lanceolata.....	Perfectly hardy.....	3 feet
Tartarean Honey-suckle	Lonicera Tartarica.....	Perfectly hardy.....	7 feet
.....	Tamarix Amurensis.....	Perfectly hardy.....	3 feet
White Lilac	Syringa Alba.....	Perfectly hardy.....	5 feet
Purple Lilac	Syringa Vulgaris.....	Perfectly hardy.....	6 feet
Persian Lilac	Syringa Persica.....	Perfectly hardy.....	5 feet
Missouri Currant	Ribes Aureum.....	Perfectly hardy.....	5 feet
.....	Caragana Arborescens.....	Perfectly hardy.....	3 feet
*40 Riga Poplar	.....	Perfectly hardy.....	12 feet

NAMES AND ADDRESSES OF PARTIES TO WHOM HAVE BEEN SENT
RUSSIAN APPLE TREES, RUSSIAN WILLOW AND POPLAR TREES
AND GRAPE VINES IN THE SPRING OF 1888.

Our object in this distribution is to obtain information as to the behavior of various plants of interest from as extended an area in the state as possible, and at the same time to disseminate as much valuable material as practicable.

These trees and vines are only distributed to those persons who agree to properly care for them and to retain their marks and numbers, and who will make reports as requested of the results of their planting.

Dr. H. B. Train,	Hokah, Minn.	Wm. F. Dunbar, Caledonia, Minn
Anthony Demo,	" "	C. J. Wheaton, "
W. H. Dunham,	" "	Jud Pope, "
Wm. H. Snure,	" "	J. E. Pope, "
Isaac Holliday,	" "	L. Lapham, "
David House,	" "	John Fishel, Brownsville, "
Jacob Daball,	" "	John Turnbull, La Crescent, "
Andrew Hartman,	" "	Sears Lilly, "
A. Wightman,	" "	John Finnigan, "
H. S. Eberhard, Mount Prairie,	"	John C. Kramer, "
Andrew Orr,	" "	E. Evans, "
Adam Coon,	Houston, "	Jacob Klein, Hokah, "
J. E. Boswarth,	Money Creek, "	W. H. Emily, La Crescent, "
J. J. Belden,	Caledonia, "	John Matheison, Austin, "
Dewain Cook,	Windom, Minn.	M. F. Norwood, Balaton, Minn.
S. D. Richardson,	Winnebago, "	E. J. Crowe, Lamoille, "
H. S. Hayes,	Hamilton, "	Q. W. Perkins, Winnebago City, "
N. E. Drival,	Caledonia, "	F. E. McIntyre, " "
John Dean,	Blue Earth, "	John Penny, Wells, "
D. Boureman,	Prosper, "	D. T. Wheaton, Morris, "
C. G. Stewart,	" "	R. E. Crane, Grand Meadow, "
John Miller,	Canton, "	M. Dunnell, Owatonna, "
M. J. Wilsie,	" "	John Harris, La Crescent, "
J. C. Russell,	" "	R. M. Probstfield Moorhead, "
G. W. Sprague,	" "	Frank Martin, Redwood Falls, "
W. B. Wilcockson,	Morris, "	W. W. Webster, Clearwater, "
O. Paulson,	Hagan, "	H. I. Pettersen, Litchfield, "
Andrew Holes,	Moorhead, "	D. F. Akins, Farmington, "
D. L. Wellman,	Frazee City, Minn.	M. L. Spicer, Renville, Minn.
Mrs. Jennie Stager,	Sauk Rapids, "	T. C. Rice, Frazee City, "
M. M. Bingham,	Ortonville, "	Dr. J. Sally, Pelican Lake, "
A. M. Sperry,	Wasioja, "	C. L. Smity, Minneapolis, "
C. W. H. Heideman,	New Ulm, "	G. W. Fuller, Litchfield, "
L. D. Mosher,	Beaver Creek, "	A. W. Sias, Rochester, "
E. P. Bertrand,	Sleepy Eye, "	Andrew Peterson, Waconia, "
C. J. Wright,	Fergus Falls, "	Chas. Luedloff, Carver, "
C. C. Roberts,	Lake City, "	Dietus Day, Farmington, "
Hon. Fred Von Baumbach,	Alexandria, "	Wm. Sommerville, Viola, "
W. W. Hawkenson,	Litchfield, "	M. Cutler, Sumpter, "
John Breen,	Ghent, "	W. J. Ludlow, Worthington, "
J. H. Biler,	Fair Haven, "	J. O. Barrett, Brown's Valley, "
K. H. Glaim,	Minnesota, "	John G. Miller, Dodge City, "
Jas. McDaniel,	Spruce Hill, "	W. J. Stubbs, Long Lake, "

NATURAL AND ARTIFICIAL FECUNDATION OF PLANTS.

We are in the habit of hearing much about the means used for improving our fruits, vegetables and flowers, and I thought a few remarks on this subject, in a direct, practical way, would be interesting.

I design, first, to indicate how fertilization in plants may be accomplished naturally, and then, how it is done artificially. To make myself the better understood, I have thought it best to define, in a general way, the great divisions of our cultivated plants and some of their fruits.

Plants are divided, according to the length of time they live, into three classes:

Annuals. Those which come from the seed, and produce seed in a single season; as beans, peas, corn, wheat, oats, barley and the like.

Biennials. Those which live two seasons come from seed one season, and die the next, after flowering; as:—turnips, beets and carrots.

Perennials. Those which live from year to year, as our forest and fruit trees, shrubs, grapevines and horse-radish.

A flower is that part of a plant in which the organs of reproduction (stamens and pistils) are situated, and which consists, principally, of a single group of these, surrounded by a floral envelope (the calyx and corolla.) But the organs of reproduction and the floral envelope are modified leaves.

The general laws which govern life prevail in plants, as in animals. They have organs of nutrition and organs of reproduction; but there is nothing in plants corresponding to the mouth and stomach and alimentary canal of animals; and nutrition takes place in a very different manner.

The organs of reproduction in plants are not permanent, but fall off after fecundation has taken place. Fecundation or crossing in plants can take place only when the plant is in blossom. For this reason, there is no danger of biennials, as carrots and parsnips, crossing the first year. Nor will plants like potatoes, artichoke, horse-radish, raspberries and strawberries when propagated by offsets, divisions, runners, cuttings or layers, fail to produce like the original. One should bear in mind, however, that these may be changed to a great extent by selection, and that at times they may sport.

As an illustration of the great improvement and the changes wrought in the plants by different methods, I have chosen the strawberry, because it is well known, and because it offers a very strong illustration of change under cultivation. In 1746, there were known, in France, where this fruit was early cultivated, only three kinds of strawberries. The varieties of the present day are almost innumerable. In the parentage of our cultivated strawberries, enter, perhaps, five different species, of which the *Fragaria virginiana*, or our common wild strawberry, bears the largest fruit. A comparison of the fruit of this, which is small, even when developed under the best circumstances, with the fruit of such a variety as the Sharpless, which under special cultivation has frequently been produced three inches broad by two inches long, will show the great change made in the size of the fruit by cultivation. These changes were brought about by cross fertilization, and the selection of the best of each kind.

Let us for a moment glance at the construction of the strawberry blossom, where the originating of these changes must commence.

The strawberries have two kinds of blossoms:

1st. What are called perfect or hermaphrodite blossoms; that is, one in which both the male and female organs are fully developed, as in Fig. 1. Examples of which are Wilson, Iron Clad, Capt. Jack and Countess.

2d. What are called pistillate; or blossoms in which the female organs are alone, or mostly developed, as in Fig. 2. Examples of which are Crescent Seedling, Manchester and Minneconjou Chief.

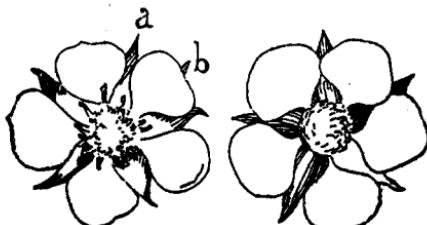
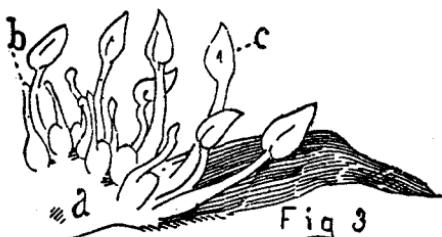


Fig. 1

Hermaphrodite Blossom
OF THE
STRAWBERRY.

Fig. 2

Pistillate Blossom
OF THE
STRAWBERRY.



CROSS SECTION OF
HERMAPHRODITE STRAWBERRY
BLOSSOM.



CROSS SECTION OF
PESTILLATE STRAWBERR
BLOSSOM.

We find these blossoms made up of several parts: what would be termed the outside of the blossom before it is opened, and the under part of the blossom after it is opened, is the calyx, and is made up of ten separate pointed leaves, each of which is called a sepal (Fig. 1a.) It remains on the berry when the fruit is ripe.

Just above the calyx, we come to a circle of five white leaf-like structures, which is the corolla; and each separate leaf is called a petal. Now, if several sepals are very carefully pulled off of a staminate variety where they separate easily from the stem, we find growing to the bottom of them several little yellow appendages. These are the stamens (Fig. 7), which are the male organs of the plant and drop off after fecundation has taken place. These are made up of a little stem with a swelling at the top. The little stem is the filament (Fig. 7 b) and the swelling at the top (Fig. 7 a) is really a little pod called the anther and is filled with a fine yellow dust, called the pollen.

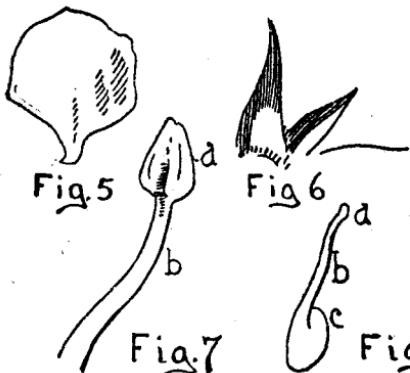


FIG. 5.—PETALS.

FIG. 6.—SEPALS.

FIG. 7.—STAMEN.

FIG. 8.—PISTIL.

If we now remove the rest of the corolla and the calyx, we have left what appears to be a very small strawberry with delicate hairs growing up all over it. These little, delicate hairs, with the little swelling at the base of each, constitute the pistils or female organs of the plant (Fig. 8). Each of these is made up of three parts: the stigma (Fig. 8 a) which is a little sticky enlargement on the tip of the hair; the style (Fig. 8 b) which is the hair itself connecting the stigma with the swelling at the base, which is the ovary or future seed (Fig. 8 c).

The little strawberry itself, or what is left after removing the seeds, is called the receptacle because it holds and supports the seeds or ovaries.

In order to have a strawberry produce fruit it is necessary that some of the dust or pollen, from the anthers of the stamens come in contact and adhere to the stigma of the pistils. By this means fertilization or fecundation is produced and the seed is formed.

Without this fecundation no seed would be formed and nature apparently is not willing to develop a luscious receptacle or berry unless she in turn can use it as a resting place for seeds. For unless the strawberry can produce seeds we can have no fruit.



STRAWBERRY PLANT WITH FRUIT, SHOWING CALYX AND SEEDS.

And just here another interesting feature comes in, and that is the fact that no matter how much pollen from an apple or pear tree or currant bush, or any other dissimilar plant, may come in contact with the pistil of the strawberry, it will not fertilize it.

The strawberry requires to be fertilized by strawberry pollen, the apple by apple pollen, and so on; each variety, generally speaking, with pollen of similar varieties.

On account of the above reason, it has in practice been found necessary, for the best success in planting such pistillate varieties as the Crescent Seedling and Manchester, to have at least one row in every seven of some strongly staminate variety, as the Iron Clad or Wilson. These latter have abundance of pollen to fertilize their own fruit and that of their neighbors. Care must be taken, however, in securing a staminate variety for fertilizing a pistillate one, that both shall be in blossom at the same time, or it will not produce the result desired.

Pollen is distributed in strawberries by insects and the winds. The anther bursts open when it is ripe, and its pollen floats on the air and is very much diffused; or some bee in its wanderings and investigations for honey, lights on the staminate plant, and the pollen collects on the hairs on his legs, and then he may go to some pistillate variety, where the pollen grains on his legs come in contact with the sticky end of the pistil and is left to produce fecundation.

Where strawberries are grown with a view of producing new varieties, fecundation is done by hand. For this purpose, three tools are required; a camel's hair brush, a delicate pair of scissors and a piece of fine muslin. If it were decided to cross two such berries as the Iron Clad and Chas. Downing the way of procedure would be something after this manner: As soon as the Iron Clad is in full bud, and before the blossom is opened, it should be covered with a little muslin bag, or wire gauze, which fits snug up to the stem, though wide enough at the top to allow the flowers to open. When the blossom has fully expanded the muslin should be removed, and the stamens carefully cut off below the anthers. The muslin is then replaced. In a few days a camel's hair brush is brushed over the stamens of a Downing berry, which has plenty of pollen dust, and then touched lightly to the pistils of the Iron Clad, when some of the

pollen dust will be found to adhere to them. The muslin is at once replaced, and when the blossom begins to fade, is removed altogether. The plants from the seed of this hand-fertilized berry will partake of many of the characteristics of both plants.

The operation would be the same when a pistillate variety like the Manchester was to be fertilized ; but there would, in all probability, be no stamens sufficiently developed to need cutting off.

DIVISION OF ENTOMOLOGY.

OTTO LUGGER.

NOTES ON THE ROCKY-MOUNTAIN LOCUST IN OTTER TAIL COUNTY, MINNESOTA, IN 1888.

The following short account of the above insect is simply intended to serve the purpose of giving a timely warning not alone to the farmers of this fair State, but also to those of the neighboring States that are likely to suffer in the case of a general outbreak. As far as can be judged at the present time, no alarming fears of a general locust plague need be entertained. History repeats itself, and past experience has fully demonstrated the fact, that this species cannot thrive for many successive years far away from its native home. The permanent breeding grounds of the Rocky-Mountain Locust have been thoroughly well confined by the labors of the U. S. Entomological Commission, in charge of that eminent entomologist, Prof. C. V. Riley. They extend chiefly along the eastern Rocky-Mountain Range, from longitude 102° to 140° west of Greenwich, and from latitude 53° to 40° north, comprising most of the levels below an altitude of 6,000 feet and above 3,000 feet. In many portions of this area they breed every year, selecting river bottoms or sunny slopes for this purpose, and lead an essentially migratory existence. This permanent breeding area gradually shades into a subpermanent region, in which locusts breed more or less frequently, and which is liable to be invaded at any time, or rather whenever the insects become very numerous in their true breeding grounds. This subpermanent region lies immediately east of the 104th or 105th meridian, and its eastern limits extend north of the 45th parallel to about the 97th meridian. In other words, it comprises the elevated plains east of the Rocky-Mountains, diminishing eastward as the altitude of the

country decreases to the level of a region intermediate between the plains and the prairies. This region includes a large portion of British America, nearly all of Dakota, western Nebraska, northwest Kansas and the northern half of Colorado. Although Minnesota may be said to be located in the temporary region, *i. e.* a region only periodically visited, yet parts of the State are unpleasantly near this boundary or danger line, and therefore apt to be overrun by hordes of hungry locusts. And such has been frequently the case, as can be seen in the reports of the commission mentioned above. It seems that locusts did more or less damage in the years 1830, 1842, 1849, 1856-57, 1863 to 1878. From 1863 to 1878 there was hardly a year in which locusts did not occur in sufficient numbers to injure the crops somewhere. When not occurring elsewhere they were surely found in the Red River Valley. They did not breed here during all these years, but sufficient new swarms came from the northwest to recruit the invading army and keep it formidable. In 1877 they destroyed alone in 19 counties 337,188 acres of wheat.

History of the Locusts in Otter Tail County—It seems that during the autumn of 1885 a few straggling specimens of the Rocky-Mountain locust landed in the very heart of the village of Perham. Here they were seen by numerous persons, and occasioned some comment, but were left undisturbed. In fact hardly any one was quite sure about the identity of these emigrants with the migratory species. Whence they came it is impossible to ascertain. For lack of entomological knowledge these suspicious insects were permitted to stay and deposit their eggs. Their offsprings were seen again in 1886, and what is worse, were allowed to grow and scatter. The actual damage done by them was but slight, not amounting to much more than the loss of the crops from a few acres. These "hoppers" created again a lively discussion in the farming community, but instead of going to war with them or trying to exterminate these dangerous foes, they were allowed to deposit their eggs in peace, and that over a greatly extended area. A few days' labor at this stage of their existence would have been sufficient to stamp out the whole brood. In 1887 this lack of knowledge and of energy bore fruit, and the existence of the real Rocky-Mountain locust became visible even to the most stubborn disbeliever. The few locusts of 1885 had increased to such an extent that the crops of 3,000

acres of wheat (and according to the estimation of others of nearly 5,000 acres) were swept away, and the threatening danger of future losses became evident, as nearly all the locusts remained in the vicinity and were known to have deposited their eggs. Many farmers lost their all, and some of the younger settlers left the vicinity in disgust. Was anything done now to stamp out the pest? Any possible doubt of this locust being the real Rocky-Mountain species could no longer be entertained, as specimens sent to the Entomological Division of the U. S. Department of Agriculture in Washington were decided to be the genuine article. Concerted action even in that year could and would have prevented any further increase, nay, could have stamped out the whole brood. But nothing was done, and the insects were allowed to scatter over a large area. Prayers and processions were almost the only things resorted to by Catholics; other pious folks claimed the locusts to be a direct visitation sent by the Almighty, and as something to be submitted to, but not to be combatted. Yet the same people had and have no hesitation to remove the weeds from their fields or gardens, or destroy other equally unpleasant things, that might with equal force be considered by them as being divine messengers.

After devastating the whole region about Perham, many of the winged locusts tried to leave that vicinity. But owing to various reasons, which will be indicated later, the great majority of them did not fly to any great distance, but deposited their eggs in suitable spots throughout the townships of Perham and Gorman, as well as in the borders of the neighboring townships of Corliss, Pine Lake, Otto, Rush Lake, Perham and Edna. The area thus infested comprised about 100 square miles. But it must not be understood by this, that the entire area indicated above was infested uniformly; on the contrary, only certain favorable localities, such as sandy, gravelly or other bare spots in the fields, roads, paths, southern slopes, etc., were selected by the female for oviposition. Wherever a field had been denuded of all vegetation it offered a good place for the female locust to deposit her eggs, and much of the threatening danger in 1888 is due to this very habit. The prairies themselves were not selected for the purpose of oviposition, nor timothy fields with a rank growth of plants. Only few swarms flew beyond the limits given above. Several of them extended their flights in a southwesterly direction beyond Otter

Tail Lake, and a number of colonies have been discovered between this lake and Battle Lake. Another swarm extended even beyond Lake Clitheral, where a number of fields were selected for oviposition. Thus far no other localities have been discovered, and all the above colonies are of a comparatively small size.

Up to the spring of 1888 nothing whatever was done to fight this ever-increasing army of locusts. Serious trouble was feared by some, while others trusted to some lucky chance that would prevent the eggs from hatching. And owing to the severe winter and a very late spring, these eggs did not hatch at the accustomed time, and consequently a rather festive feeling prevailed in the village of Perham; so much so, that the existence of locusts in that vicinity was even denied, so as not to scare away emigration or affect the sale of land. Whoever doubted was considered as a kind of evil genius to the neighborhood, or designated as a crank. But this premature feeling of security was of short duration, and as the young locusts hatched everywhere in June, farmers became alarmed. Governor A. R. McGill was appealed to for assistance, but having received such conflicting statements from the citizens of Perham themselves, he was naturally in doubt as to the real merit of the case. At his request, and with the consent of the regents of the State University and the Experiment Station, I went to Perham to investigate the existing true state of affairs. In the regions already indicated I found most of the eggs hatched or hatching, thus forming a very serious danger to the whole State. As the citizens and farmers had applied for assistance, I had several meetings called together with the view of ascertaining exactly what they really wanted and needed. The resolutions there passed were sent to the governor, and a committee of five was appointed to take the matter in charge. Feeling satisfied that the locusts in that vicinity were numerous enough to destroy the greater part of the crops, not alone in Otter Tail county, but in the whole State, I immediately reported this dangerous state of affairs to the governor, who, with rare promptness, at once set to work to afford all the relief in his power. Coal-tar, kerosene, sheet-iron and canvas, in sufficient quantities to make a large number of pans to catch the young locusts, were quickly sent to the nearest points, and more supplies are constantly forwarded wherever and whenever necessary. The vice-president of the Northern Pacific railroad, seeing the importance of a persistent resistance

to the further increase of the hoppers, at once consented to send all the necessary material to the affected districts free of charge, and the merchants of St. Paul acted with great liberality in responding to the request of the governor to ship the needed material, although he could only promise to pay their bills in an uncertain future. As there was no money on hand which could be applied by the governor for the purpose of fighting locusts, it was necessary that the county commissioners of Otter Tail county should furnish the same. They did so, having received the promise that they would ultimately be refunded by the legislature. At present most of the farmers, and many hired men, are at work killing locusts, and in most places with very good effect, as the heaps of their blackened victims clearly indicate. Fifty bushels and more were killed every day during the week ending June 24th, and many more at the time of writing. With persistent efforts most of the crops will be saved, and the locusts will be greatly reduced in numbers. Of course, it is now impossible to kill all or stamp out the pest; but as the season is exceedingly favorable to the vegetation, and very unfavorable to the locusts, much can be done to lessen the evil. Aided by the timely assistance given by the governor, farmers have begun to gain courage, and with it the will to resist all they can. Early in the season, with their fields covered with young hoppers, many farmers considered everything lost, and gave up all hope to save their crops. This despondency formed a great drawback in organizing them to united and persistent efforts in fighting their enemies, but it has now happily greatly disappeared, and hope has revived in proportion. There are always some dissatisfied persons in every community; they are never happy if not brewing mischief, and their only delight seems to be found in creating ill-will and discord among their fellow-citizens. I am sorry to state that Perham and vicinity is not entirely free from such persons, and that their actions — I hope unintentionally — have done some harm in delaying co-operations against what should be considered a common enemy, the Rocky Mountain locust.

Reason for the rapid increase of Locusts near Perham.— We have already seen that Otter Tail county is unpleasantly near the danger line and that locusts may very easily reach that region. In normal years, when the amount of rain during the growing months is not below the average, the conditions of these

extensive prairies, in a county spotted with numerous and beautiful lakes of large size, are not suitable to the existence of an insect that loves a high and dry country as a home. In wet years the Rocky-Mountain locust leaves a region as soon as it is enabled to do so, and it can never remain there for a series of years without suffering in health. But everything during the past two years has been in favor of this intruder. A severe drought prevailed throughout the infested region, and the locusts naturally felt at home and multiplied without any other check than its numerous enemies, parasitic and cannibal insects, birds, and mammals. When the locusts reached their full size and became winged, they evinced no desire to fly away in search of better homes. Their instinct prompted them to fly, but simply in search of suitable places in which to deposit their eggs. And as such places abounded in their immediate neighborhood, they consequently selected them for that purpose. Only a very few swarms, perhaps caught by a stronger wind, were borne away to some greater distance, and lodged in the other localities already mentioned.

Difficulties in combatting locusts in the infested region.—From the very fact that numerous farmers had lost their entire crops in 1887, quite an unexpected difficulty arose in successfully combatting these insects. Finding their fields full of eggs, and despairing of getting a crop in the ensuing year, many did not plow them at all, but engaged in other work, or moved away altogether. Others plowed but a limited proportion of their fields, either for lack of seed, or for fear of a second entire loss of their crops by these insects. Consequently there were larger or smaller areas of unplowed fields scattered among plowed and seeded ones. And as these stubble-fields contained the largest numbers of eggs, which hatched in the course of time, farmers with grain growing upon their land had not alone to fight the young locusts produced in its close proximity, but also those coming from the adjoining and unplowed stubble-land. At first the matter of fighting the young hoppers was very easy and simple, for it is a fact that *not one locust hatched in fields plowed during the fall or early spring*. Not that the plowing destroyed the eggs, but simply because the eggs were turned and plowed under, so that the young hatching therefrom could not reach the surface. The female locust, in depositing her egg-masses, first forces a hole in the ground by means of the peculiar two pairs

of horny valves at the tip of her abdomen; by opening and shutting them rapidly this is readily accomplished. As soon as the egg-mass or egg-pod is deposited, the female fills up the entrance leading to it with a mucous matter. This material is more or less impervious to water, but is at the same time very light and easily penetrated, thus forming no obstacle to the exit of the young locusts in spring. If such egg-pods are plowed under this place of exit is closed for good, and as the young and soft locusts cannot dig, they are doomed to perish. In several fields which were plowed a second time, late in spring, most of the eggs hatched, and the young had no difficulty in reaching the light. To keep the approaching hordes of young locusts away from the cultivated fields, ditching was adopted as one way of catching the enemy. As a rule, however, ditching proved of little use. The soil in the infested region is so light and sandy, that the edges of the ditch soon caved, and as the month of June was rather rainy and stormy, ditching was soon abandoned as a poor means of preventing the locusts from entering the cultivated fields. Farmers owning unplowed fields could not be made to kill the young hoppers upon them without pay, and no money was available for this purpose until the County Commissioners had concluded to vote the necessary amount. As soon as farmers that had nothing to lose or gain by working upon their own fields received wages, they assisted in the work of extermination, earning now sufficient means to support their families and obtain feed for their horses. Fields owned by non-residents, or by speculators, also harbored many locusts, and had to be worked by hired labor. Another difficulty arose from the lack of straw in the affected districts. Owing to the devastation caused by the locusts in 1887 but little straw was left to be used to burn over fields covered with the very young insects. Burning being a well known means of killing them, was resorted to whenever and wherever possible. But the fields in many places had been burned over altogether too soon, and there was nothing left for this purpose at the right time. Locusts usually hatch early in May in the vicinity of Perham, and as fields had been burned over at that period, or long before any locusts had hatched in 1888, all this labor proved much worse than useless.

Different behavior of the locusts in 1887 and 1888.—In the former year the locusts hatched early in May, and almost imme-

diately commenced their destructive work. Most of them hatched in timothy fields, which contained many more or less bare spots, the effects of the severe drought of the previous year. The young locusts marched in large bodies to the nearest field, and, entering it, devoured every plant, so that in the course of a very short time the fields were as bare of vegetation as a well trodden road. The insects went through their successive molts or stages with great regularity, and towards the middle of June nearly all the damage possible by the unfledged insects had already been inflicted. The year 1887 was also distinguished by a very dry summer, and cultivated plants showed but very little vitality, for as soon as the locusts attacked them they wilted and died at once. The winged insects kept moving from place to place, and did considerable damage. Nothing was secure, and they would eat with almost equal relish all kinds of plants. Even the few pine trees planted in the yards of Perham were not alone denuded of their foliage, but the very bark was bitten off and devoured. Clothing of any kind left in garden or field was soon consumed by these omnivorous brutes. They congregated in such immense numbers in some of the roads that people hesitated to drive their horses through these blinding swarms. In 1888, at least up to the time of writing, things look quite different. Owing to a severe winter and a late spring, the eggs did not commence to hatch until early in June. As already stated, most of the eggs in the unplowed fields and in the denuded fields of timothy hatched. The young locusts, however, did not at once commence to travel or enter the fields of young grain. They remained in the neighborhood of their birthplace for a long time, and did not travel together in large or compact masses, but rather in small and irregular detachments. Entering fields of wheat, they have done thus far comparatively but little damage. Of course, the line of their march could at first be distinctly seen, and the edges of fields invaded by them would be more or less denuded for one or more rods, but were never eaten as bare as in 1887. Rank plants of wheat, perhaps growing upon better manured soil, are not attacked at all, and the hoppers invariably select only weaker plants. Masses of young locusts, densely covering a space of a square foot or less, could and can be seen huddled together, neither eating nor moving until disturbed; they will remain in such position for many hours, even days, and this not for the

purpose of molting, as was my first impression in seeing them act in this queer manner.

With the exception of some few fields, the real damage done thus far is but slight in comparison of what might have been the case. Contrary to their usual habits, very large numbers of locusts of different sizes congregate in the woods, and remain there for days without any visible means of support, moving about in an aimless sort of a way. They evidently feel but ill at ease, and would like to leave the region if enabled to do so. Some people claim that these gatherings are real indignation meetings, because the weather is so cold and damp, and the fields are so loaded with the sweet odors of coal-tar and kerosene. The insects are also very irregular in passing through their successive molts. I had a considerable number of them confined in a small and isolated field of wheat, where they could be observed. All the members of this little army were born at about the same date, at least they were all of the same size and appearance when first obtained. Now, nearly three weeks later, some have already passed the fourth or first pupal stage, while others are in the second stage, thus indicating a rather remarkable difference in what must be considered vitality.

Reason for the slow and irregular growth.—The key to this slow and irregular growth is found almost solely in the atmospheric conditions which have prevailed since the hatching of the eggs took place. With the exception of a very few real warm days, so very beneficial to the well-being of the locusts, we have had a series of cool, and even cold days. Frequent rains, so important a factor in the infested region for a rapid growth of the grain, aided vegetation, but retarded the growth of locusts. During these rainy spells they did not eat at all, but crowded and huddled together as if seeking protection and warmth from each other. Nor did the strong wind prevailing on days when it was not raining improve matters for them, for if they jumped at all, they were bodily lifted up and rolled over and over again in a most ridiculous way, and their long hind legs would frantically kick about, as if kicking against fate. The atmospheric conditions were thus far so beneficial to the plants that they simply outgrew any bodily harm done them by the hoppers, and even the borders of fields, partly denuded some time ago, begin to look green again, and many of the plants eaten

clear down to the ground will grow again, and may, under continuous favorable weather, still produce crops.

All indications at the present time point to one thing: the Rocky-Mountain locust is getting weak in its constitution, and is anxious to leave as soon as enabled to do so. If the prevailing favorable weather should last, there is but little doubt that the whole brood will perish before another season is over. But to make the death of this dangerous insect sure beyond any doubt whatever, it behooves the farmers of the infested districts to kill all the locusts they can kill, as the only good "hopper" is a dead one.

The various parasites—and a large number have been seen—as well as the different species of birds which were observed to eat young locusts, will be mentioned or described in the next bulletin. The various methods employed to stamp out the intruders, and the results of the labor expended for this purpose, will also be considered later, when they become more evident.

In conclusion of this short account of the locusts in Otter Tail county, I wish earnestly to draw the attention of the farmers of the whole State to one thing, viz: *To look out for any swarm of locusts that may arrive in their district, to watch carefully for the places in which eggs are laid, and to co-operate with their neighbors to prevent their hatching, by plowing the infested fields during fall or early spring.*

JULY 1st, 1888.