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Potato Scab. Three Injurious Insects

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POTATO SCAB.
THREE INJURIOUS INSECTS.

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I. EXPERIMENTS WITH POTATO SCAB.

THOMAS A. WILLIAMS, Botanist.

During the seasons of 1894 and 1895 a series of experiments on the treatment of potato scab were carried out at the station farm. There were two primary objects in conducting these experiments: first, to test the practicability of certain methods of treatment, particularly in land already infested with scab; second, to test the power of the various varieties to resist the disease, and also their behavior toward certain fungicides.

The fungicides used were corrosive sublimate (bichloride of mercury), bordeaux mixture and eau celeste. The seed was treated by immersion before cutting and by spraying after being dropped into the furrow.

In one series of plats the land was known to be infested with scab, having been planted to potatoes for at least five consecutive seasons and producing a crop more or less badly scabbed. In the other series the land had never been planted to potatoes and was therefore supposedly free from the fungus producing the scab.

The season of 1894 was so dry that the conditions were very unfavorable for the development, either of the potatoes or of the scab-fungus. As a result the yield was very light, and, with but few exceptions very little scab was found, even in the infested land. The difference between treated and untreated plats was not very marked, what there was being in favor of the former.

The experiments of the past season were much more satisfactory and show some very interesting facts. The tables which follow give the results of the experiments on infested ground.

The early part of the fall was very favorable for the development of the scab and, as the potatoes could not be dug as soon as ripe, the amount of scab shown by the tables is greater than it would have been under ordinary circumstances.

In all cases a *single scab* on a tuber was sufficient to place it among the "affected" lot. In order to get a proper idea of the real damage done by the scab, both the *amount* of scaby product and the *degree* of scabbiness must be taken into consideration. It will be noticed that, as a rule, the *larger*, *older* tubers are most likely to be scabby.

A TEST OF SOLUTIONS OF CORROSIVE SUBLIMATE AT VARIOUS STRENGTHS.

The corrosive sublimate was applied in the form of solutions of three different strengths. Solution No. 1 contained 2⅙ ounces of corrosive sublimate to 15 gallons of water; No. 2 contained 2⅙ ounces to 5 gallons of water; No. 3 contained 2⅙ ounces to 2½ gallons of water. Stated in proportions the solutions would be about as follows: No. 1, 1 to 1,000; No. 2, 3 to 1,000; No. 3, 6 to 1,000.

In this experiment the seed was treated in two ways. One lot was immersed before cutting the other was first cut and dropped and was then sprayed in the furrow with an ordinary hand sprinkler. The time of immersion varied according to the strength of the solution. The seed was allowed to remain 1½ hours in solution No. 1; ½ hour in solution No. 2; and ¼ hour in solution No. 3.

The solutions were kept in barrels and the seed was placed in baskets or gunny sacks and then immersed for the requisite length of time. As soon as it was taken from the solutions the seed was cut and planted.

Twenty hills of three pieces each constituted the unit throughout the experiment.

The results of the experiment are shown in table No. 1 which follows:

TABLE I.

			EARLY OHIO.				No. 47.				POLARIS.			
			Lbs.	Oz.	No.	Notes on Degree of Scabbiness.	Lbs.	Oz.	No.	Notes on Degree of Scabbiness.	Lbs.	Oz.	No.	Notes on Degree of Scabbiness.
Solution No. 1 .... 1 to 1,000.....	Immersed	Free	13	9	107	Scabs few and shallow.	15	13	74	Scabs few and shallow.	11	4	67	Scabs few and shallow.
		Scabby..	5	2	33		5	11	22		5	15	25	
	Sprayed..	Free	10	9	99	Scabs plentiful and deep.	....	....	....	.....	15	14	110	Scabs plentiful and deep.
		Scabby..	10	2	54		....	....	....	.....	6	13	25	
Solution No. 2 .... 3 to 1,000.....	Immersed	Free	15	11	102	Scabs few and shallow.	11	5	75	Scabs few and shallow.	14	8	116	Scabs few and shallow.
		Scabby..	6	4	26		10	11	42		4	9	15	
	Sprayed..	Free	15	....	103	Scabs few and shallow.	18	....	95	Scabs few but deep.	15	12	94	Scabs few and shallow.
		Scabby..	5	6	20		5	....	14		3	2	15	
Solution No 3 .... 6 to 1,000.....	Immersed	Free	12	14	59	Scabs plentiful and deep.	....	....	....	.....	13	15	71	Scabs few and shallow.
		Scabby..	5	8	24		....	....	....	.....	4	12	13	
	Sprayed..	Free	10	13	111	Scabs few and shallow.	21	5	107	Scabs very few & very shallow	16	10	77	Scabs few and shallow.
		Scabby..	3	....	13		1	8	7		4	3	13	
Check.....	Untreated	Free	17	10	125	Scabs few and shallow.	16	8	100	Scabs plentiful but shallow.	14	11	77	Scabs plentiful and deep.
		Scabby..	5	3	26		8	1	29		10	9	32	

Table II gives the results of the comparative test of the three fungicides used; corrosive sublimate 1:1000, eau celeste, and bordeaux mixture.

Eau celeste was made according to the following formula: "Dissolve 4 pounds of copper sulphate in 10 gallons of water, and stir in 5 pounds of sal soda; then add 3 pints of strong aqua ammonia; dilute to 45 gallons." It is the modified solution in common usage in the United States.

The bordeaux mixture was made as follows: "Dissolve 6 pounds of copper sulphate in a wooden or earthen vessel. In another tub or vessel slake 4 pounds of *fresh* lime; add enough water to reduce it to the consistency of a thick whitewash. Pour this slowly into the vessel containing the copper-sulphate solution, using a coarse gunny sack stretched across the top of the vessel for a strainer. Dilute to 45 gallons.

TABLE II.

			EARLY OHIO				No. 47.				POLARIS.			
			Lbs.	Oz.	No.	Notes on Degree of Scabbiness.	Lbs.	Oz.	No.	Notes on Degree of Scabbiness.	Lbs.	Oz.	No.	Notes on Degree of Scabbiness.
Corrosive Sublimate ..... 1 to 1,000.....	Immersed	Free	14	10	88	Scabs few but deep.	20	11	137	Scabs few and shallow.	11	4	67	Scabs few and shallow.
		Scabby..	5	10	22		3	9	16		5	15	25	
	Sprayed..	Free	14	8	90	Scabs few and shallow.	16	2	97	Scabs few and shallow.	18	8	115	Scabs few and shallow.
		Scabby..	2	13	14		4	2	14		2	2	9	
Eau Celeste.....	Immersed	Free	12	12	72	Scabs few and shallow.	12	12	85	Scabs very few and shallow.	8	1	46	Scabs few and shallow.
		Scabby..	2	5	7		....	8	3		2	12	9	
	Sprayed..	Free	8	2	53	Scabs few and shallow.	8	6	34	Scabs plentiful and deep.	6	8	35	Scabs few and shallow.
		Scabby..	3	8	15		9	12	33		8	8	31	
Bordeaux Mixture.	Immersed	Free	14	1	67	Scabs few and shallow.	17	3	67	Scabs few and shallow.	4	1	26	Scabs plentiful but shallow.
		Scabby..	2	2	7		3	....	11		5	....	17	
	Sprayed..	Free	8	10	42	Scabs very few and shallow.	15	3	85	Scabs few and shallow.	12	14	66	Scabs few and shallow.
		Scabby..	....	2	1		4	2	14		5	....	14	
Check	Untreated	Free	11	6	71	Scabs plentiful and deep.	12	12	95	Scabs few and shallow.	....	....	....	.....
		Scabby..	6	11	30		5	2	19		....	....	....	.....

In table III the results of the variety tests are given.

It will be noticed that, of the varieties used, Clark's No. 1, No. 26, Thorburn, Polaris, Beauty of Hebron and No. 21, were very much affected by the scab, while Sunrise, No. 4, No. 28, and No. 59, were those least affected. In every case, except that of Polaris, the treatment very materially reduced the amount of the scabby product as well as the degree of scabbiness. In many cases varieties that were very badly scabbed when untreated gave but a small amount of scabby tubers when treated. It may be noted that in the other experiments Polaris gave much better results from treated seed.

In all cases treated seed gave a product practically free from scab when planted in the uninfested land.

The experiments of both seasons seem to indicate that the thicker skinned, darker colored varieties are less likely to suffer severely from scab than the paler colored, thin-skinned ones. This question needs further study however before any very definite statements can be made.

TABLE III.

		IMMERSED 1½ HOURS IN CORROSIVE SUBLIMATE, 1:1000.				UNTREATED.			
		Lbs.	Oz.	No.	NOTES ON DEGREE OF SCABBINESS.	Lbs.	Oz.	No.	NOTES ON DEGREE OF SCABBINESS.
No. 59	Free	16	14	109	Scabs very few and shallow	15	1	90	Scabs plentiful and deep.
	Scabby	....	14	3		4	1	17	
No. 58	Free	14	1	98	Scabs plentiful but shallow	10	12	94	Scabs plentiful but shallow.
	Scabby	5	8	24		8	4	37	
No. 40	Free	11	2	61	Scabs plentiful and deep	7	6	33	Scabs plentiful and deep.
	Scabby	2	13	11		7	2	19	
No. 28	Free	16	12	131	Scabs very few and very shallow	13	11	114	Scabs plentiful and deep.
	Scabby	....	12	7		5	14	35	
No. 18	Free	6	7	54	Scabs plentiful but shallow	10	11	87	Scabs plentiful and deep.
	Scabby	4	13	23		5	10	31	
No. 63	Free	12	4	85	Scabs few but deep	9	10	83	Scabs plentiful and deep.
	Scabby	3	2	15		4	6	21	
No. 21	Free	12	2	71	Scabs few and shallow	9	12	79	Scabs plentiful and deep.
	Scabby	2	8	9		9	9	37	
No. 4	Free	20	13	110	Scabs very few and shallow	19	12	73	Scabs plentiful and deep.
	Scabby	1	13	5		7	10	38	
No. 7	Free	19	2	184	Scabs very few and shallow	14	2	119	Scabs plentiful but shallow.
	Scabby	1	....	4		6	....	28	
No. 16	Free	7	10	45	Scabs few and shallow	5	8	42	Scabs plentiful and deep.
	Scabby	....	2	11		3	14	22	
Early Minnesota	Free	23	7	192	Scabs very few and shallow	10	11	106	Scabs few but deep.
	Scabby	1	8	10		11	....	68	

TABLE III.— *Concluded.*

		IMMERSED 1½ HOURS IN CORROSIVE SUBLIMATE, 1:1000.				UNTREATED.			
		Lbs.	Oz.	No.	NOTES ON DEGREE OF SCABBINESS.	Lbs.	Oz.	No.	NOTES ON DEGREE OF SCABBINESS.
Sunrise	Free	19	2	125	Scabs very few and shallow.	22	4	133	Scabs few and shallow.
	Scabby	2	6	14		2	8	12	
Early Six Weeks	Free	13	6	92	Scabs few and shallow.	14	10	128	Scabs plentiful and deep.
	Scabby	6	9	30		6	1	32	
Beauty of Hebron	Free	10	4	81	Scabs plentiful and deep.	5	12	41	Scabs plentiful and deep.
	Scabby	7	10	39		8	11	50	
Polaris	Free	7	1	67	Scabs plentiful but shallow.	2	14	27	Scabs plentiful and deep.
	Scabby	16	3	87		10	14	55	
Gov. Rusk	Free	13	4	97	Scabs few and shallow.	8	8	55	Scabs plentiful but shallow.
	Scabby	3	6	24		7	8	40	
Early Ohio	Free	9	10	98	Scabs few and shallow.	7	5	59	Scabs plentiful but shallow.
	Scabby	5	8	30		9	6	46	
Thorburn	Free	17	15	125	Scabs few and shallow.	8	6	87	Scabs few and shallow.
	Scabby	4	9	19		11	6	48	
Vanguard	Free	16	12	104	Scabs few and shallow.	6	1	48	Scabs plentiful but shallow.
	Scabby	9	4	40		8	6	37	
Clark No. 1	Free	9	4	56	Scabs plentiful and deep.	5	....	41	Scabs plentiful and deep.
	Scabby	8	4	46		9	5	43	
No. 26	Free	8	8	62	Scabs few but deep.	8	8	55	Scabs plentiful but shallow.
	Scabby	2	12	15		11	4	43	

SUMMARY OF RESULTS.

1.—Seed treated with corrosive sublimate will give a product practically free from scab, if planted in uninfested land.

2.—Thorough treatment will very materially reduce the amount of scab when the seed is planted in infested land.

3.—There seems to be very little difference in the effectiveness of the three different solutions of corrosive sublimate used, so long as the time of immersion is kept proportionate to the strength of the solution. More care is necessary however, in using the stronger solutions.

4.—In immersing it is best to treat the seed before cutting.

5. Eau celeste and Bordeaux mixture are both effective against the scab fungus, but both seem to affect the yield more or less.

6.—In the infested land spraying was quite as effective as immersing when Bordeaux mixture or the stronger solutions of corrosive sublimate are used. It must be remembered however that the seed used was quite free from scab.

7.—It seems that the thicker-skinned, darker colored varieties are better able to resist the attack of the disease.

8. Potatoes should not be allowed to remain in the ground long after ripening, especially if the season is wet.

THREE INJURIOUS INSECTS.

THE BOX ELDER TWIG-GALL MOTH.

(*Proteopteryx spoliana.*)

For a number of years past the box elder trees in Nebraska and the Dakotas have been troubled more or less by an insect which attacks the young twigs and causes gall-like swellings to be formed. As the attack is usually made at or near the apex of the twig very little increase in length can take place that season.

For some time there was considerable doubt concerning the insect causing the trouble. In 1893, however, we succeeded in breeding it in large numbers. While looking over the box elders for plant lice a great many of the twigs were found to be infested with what seemed to be a lepidopterous larva. Only the new growth of the season contained the insects and in every case they had bored into the twig at or near the axil of a leaf. A quantity of the twigs were collected and put into a breeding cage in the hopes of obtaining the mature insect.

As soon as the larvæ became full grown they cut their way out of the twigs and burrowed a short distance into the earth and rubbish at the bottom of the cage. Here a cocoon was made out of particles of earth and pieces of rubbish, cemented together and the larva turned into a reddish-brown pupa. About the 20th of June the moths began to emerge, and they kept coming out for nearly a month.

Though we were not able to prove it in our breeding experiments, it is quite certain that the insects from the eggs laid by this second generation of moths pass the winter in the ground in the pupal state and emerge the following spring. At any rate the insect is certainly at least two-brooded.

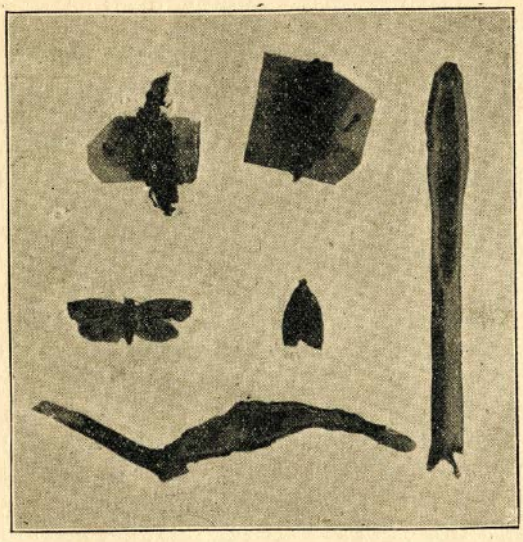

FIG. 1.—Box Elder Twiggall Moth, showing the moth with wings expanded and at rest, the work of the larvæ in the twigs and cocoon with pupa-cases protruding. [From a photograph.]

The Moth is a small gray insect, expanding nearly ¾ of an inch, with the front wings mottled with brown and provided with little tufts of scales, and with the hind wings brownish gray and fringed with hairs. It is shown in Fig. 1 with wings at rest and also expanded.

The moths are occasionally taken at lights during the summer.

The Larva is about ¾ of an inch long and of a whitish color.

The Pupa is about half an inch long, reddish-brown with transverse rows of blackish spine-like tubercles on the back. When about ready to shed the pupal skin the insect works its way out at one end of the cocoon and the pupa-case is left all but the posterior segments protruding. Fig. 1 shows two cocoons with the pupa-cases protruding from one end.

METHOD OF COMBATTING.

The only means which promises to be very effective is spraying with London purple or Paris green just as the eggs are hatching. If the treatment is thorough enough to get rid of the first brood it is not likely that more than one or two applications will be necessary. After the larvæ have bored into the twigs nothing can be done except to cut and burn affected parts of the plant. This can be done easily when the trees are not numerous and are small but is not practicable on a large scale.

At least two species of hymenopterous parasites were bred from this insect, one of which was usually present in considerable numbers.

THE WEB-SPINNING SAW FLY OF PLUMS AND CHERRIES.

(*Lyda spoliana.*)

This insect is one of the most destructive species attacking our plums and cherries. It feeds upon all the common forms of both wild and cultivated sorts, but is found more often upon the common wild plum (*Prunus Americana*) and the sand cherry (*Prunus pumila*). It has been quite abundant in this region for the past four years and probably longer.

The mature insect usually makes its appearance the second week of June. Egg laying begins about the 20th, and the young hatch out in a very few days. In 1893 the insects were taken in the act of egg laying on the 20th of June. Many were taken at about the same time in 1894. In 1895 the eggs were nearly all hatched by the 20th. The present season males and females were taken in copulation on June 10th, and less than a week later (June 15th) eggs were found in abundance, a large majority already hatched.

The eggs are deposited in close masses along the under side of the midrib of the leaf, the long axis of the egg lying parallel with the midrib. The younger leaves are invariably selected and the eggs laid before the leaf has expanded.

Immediately on hatching the young larvæ begin to spin a web and feed through or crawl over to the upper surface of the leaf. As they continue to grow they travel to other

leaves and envelope all in a tough web not unlike that of the tent caterpillar. A large colony will spread over the whole side of a tree before the insects become full-grown.

When ready to pupate the larvæ go to the ground and gradually envelope themselves in a cocoon, turn to a pupa and emerge again in the late spring or early summer, a mature insect.

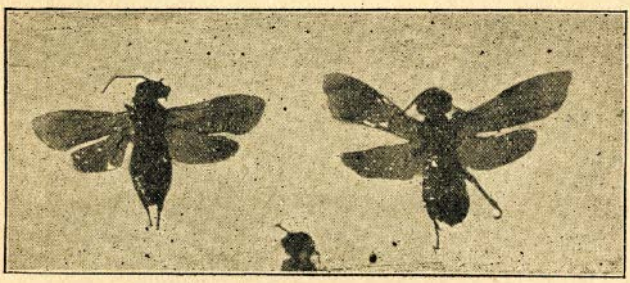

FIG. 2.—Plum and Cherry Saw Fly. Two females. About onethird larger than natural size. [From a photograph.]

FIG. 3.— Egg moss on plum leaf. Natural size. [From drawing by E. N. Wilcox]

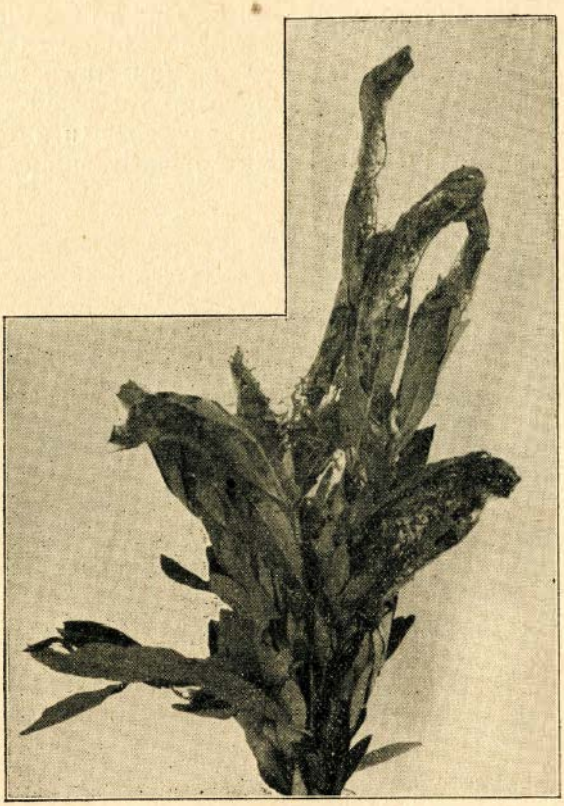

FIG. 4.—Bunch of sandcherry, showing web and the larvae at work. [From a photograph.]

The Egg is narrowly oblong-elliptical, smooth, shining, yellowish-white, and about one-twentieth of an inch long.

The Larva is pale greenish-gray, with an irregular, yellowish band extending along each side, honey-yellow head, black legs, eyes, anal plates and antennae, and black markings on the first thoracic segment above and on all three below. The last segment of the body is provided with a pair of black, false legs, by means of which the insect pushes itself about through the web. The mature larvae is about three-fourth of an inch long.

The Mature Fly is a much flattened insect with a shining black body, head, antennae and feet, and reddish legs. The wings are smoky, with shining black veins and a black spot on the fore part of each front wing. The males are about five-sixteenths of an inch in length and the females are somewhat larger.*

METHOD OF COMBATTING.

Careful spraying with Paris green at the right time is perfectly effective in keeping this insect in subjection. Spraying should be done as soon as possible after the eggs hatch and before the insects have time to spin large webs. The poison should not be used stronger than one pound to 300 gallons of water as the leaves of the stone fruits are tender and liable to injury if the insecticide is too strong.

THE WHEAT STEM MAGGOT OR AMERICAN MEROMYZA.

(*Meromyza Americana Fitch.*)

For some years past inquiries have been received regarding

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*Mr. Marlott of the Department of Agriculture, at Washington, D. C., to whom the sawfly was sent for determination, calls it a new specie and sends the following specific name and description.

Lyda rufipes n. sp.

Female:—Length 11 mm; expanse 18 mm; robust, flattened; head very coarsely, rugosely punctured, thorax with more scattered and finer punctures, shiny; abdomen very finely shagreened; anterior tibiae without side spur; cross vein of medium cell very rudimentary, scarcely projecting one-third width of cell; antennae 21 jointed, third joint three times as long as fourth; claws rather deeply and finely notched; color black, shining; mandibles and legs for the most part reddish-yellow; extreme tip of posterior tibiae and all tarsi, except base of metatarsal joint of fore and middle legs, brownish black; elongate spot on center of clypeus, spot at base of mandible, and at upper inner angle of compound eyes, together with the tegulae and base of wings, whiteish-yellow; wings nearly hyaline, nervures including stigma, dark brown, almost black; a very slight smoky shade obscures outer half of both wings.

Male agrees with female in structural and colorational features but is about one-fifth smaller.

This species goes in the second section of the genus Lyda, characterized by the absence of side spurs on the anterior tibiae, and in tribe 1, characterized by a greatly elongated third antennal joint, and the incomplete cross nervure of the median cell of the anterior wings. It does not agree with any of the described American species, nor does it seem to harmonize with any of the European species.

Described from two specimens, male and female, collected on plum and cherry, at Brookings, S. D.

the cause of a "blighting of the heads of wheat," which has been more or less common in various parts of the state. In most cases only the blighted heads were brought in, having been broken off at or above the upper joint of the stem, and no apparent cause of the trouble could be found. Two years ago some of the wheat on the college farm contained a few of these blighted heads and investigation soon proved that the cause was a small insect which worked in the stem immediately above the upper joint.

An attempt to breed the insect from the straw met with a failure. None of the material obtained contained living maggots, but all had been parasitized by a small wasp-like insect.

The following season we were more successful and were able to prove that the cause of the trouble was a small fly.

The young maggot works in the tender tissues of the stem above the upper joint and within the sheath of the leaf, and often succeeds in cutting the stem off, thus keeping nourishment from reaching the head and causing it to blight and turn white. According to Professor Forbes and Professor Webster the insect has at least three annual broods in Illinois and Ohio. They give the life history substantially as follows: From young which have hibernated the mature insects of the first brood appear. These lay eggs which hatch into the maggots which attack the stem as described and cause the blighted heads. These maggots pupate in the straw and soon after the perfect insects of the second brood appear. These lay eggs in the volunteer wheat where the mature insects of the third brood are developed. The third brood deposits its eggs in the young plants of winter wheat and the maggots produced from these eggs hibernate and develop into the first brood of the next year. Professor Lugger* thinks that here in the northwest, where only spring wheat is grown and where very little volunteer wheat is found, the insect must have some different method of passing the fall and winter months. He suggests that it may attack some of our native grasses, for example, wild rye, blue stem, etc. He gives the following excellent description of the various stages of the insect.

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*Bull, 43, Minn. Exp. Sta. p. 210.

FIG. 5.—The Wheat Stem Maggot.

"The adult flies about 1-18 of an inch long, are of a pale yellowish-green color. The large head is marked with a triangular black spot at the base, inside of which are located the three simple eyes; the large compound eyes possess in life a beautiful bronze color. The thorax is marked with three longitudinal bands; the abdomen is also ornamented with three longitudinal bands which are interrupted at the sutures but more or less confluent toward the posterior end. The color of the under side of the fly is uniformly yellowish-green except two triangular spots upon each side above the posterior and middle coxae. The legs partake of the same general color; the thighs are slightly darker and the tibiae and tarsie dusky. The hind pair of thighs are very much swollen and are provided on the under surface with two rows of small spines. The hind tibiae are very strongly curved. The two large basal points of the antennae are yellowish.

"The eggs of the American Meromyza are glistening white with longitudinal ridges; the space between the ridges is faintly reticulated. They are very elongated, being .023 of an inch long and .005 of an inch broad.

"The larva or maggot is very pale green and very slender, being about ¼ of an inch long by 1-32 of an inch wide. Its head is provided with a pair of black-toothed hooks. The covering of the apparent pupa is simply the shrunken larval skin, which protects the true pupa forming inside. As soon as the real pupa is formed it becomes visible through the transparent larval skin and is seen to be also of a pale green color. It is about 1-6 of an inch long and about 1-30 of an inch broad. As the imago is formed inside the pupa the eyes, wing-pads and legs become apparent."

At present very little in the way of direct treatment can be recommended. When we know how the insect passes the autumn and winter months we may be able to devise some method of combatting it.

Through the kindness of Professor Lugger we are able to reproduce his illustration of this insect and its parasite. The plate shows three blighted heads on one side of which is shown the pupa and the work of the maggot in the straw, on the other side is the mature fly, magnified many times.

The parasite is shown below. From our experience it is quite probable that these are plentiful enough to keep the pest in check under ordinary conditions.