KENTUCKY

AGRICULTURAL EXPERIMENT STATION

OF THE

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BULLETIN NO. 66.

TOBACCO.

LEXINGTON, KENTUCKY,
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KENTUCKY

Agricultural Experiment Station.

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KENTUCKY AGRICULTURAL EXPERIMENT STATION,

LEXINGTON, KY.

BULLETIN NO. 66.

TOBACCO.

Test of Fertillizers.

BY M. A. SCOVELL AND R. J. SPURR.

The test with fertilizers on tobacco is a continuation of our work of last year, results of which we published in Bulletin No. 63.

It has been shown from our experiments heretofore that phosphoric acid, or phosphoric acid and nitrogen, without the assistance of potash compounds had little if any effect on increasing the yield of tobacco on our land. Therefore in our plan of experiments no plots were reserved for applying phosphoric acid or nitrogen alone or the combination of the two.

Plots 1, 2, 4 and 5 contained 1-10 acre each. Plots 3a and 3b, 1-20 acre each.

The plan adopted was as follows:

Plot 1—Received 20 pounds of crude nitrate of potash from tobacco stems and 24 pounds dissolved bone.

Plot 2—16 pounds of sulphate of potash.

Plot 3a—No fertilizer.

Plot 3b—No fertilizer until July 24th, when ten pounds of nitrate of potash was sown broadcast.

Plot 4—48 pounds double carbonate of potash and magnesia.

Plot 5—20 pounds of crude nitrate of potash.

The nitrate of potash used in the experiments was obtained from Henderson, Ky., and is a by-product, resulting from concentrating the extract of the stems or mid-ribs of the leaf of tobacco.

The analysis showed this by-product to contain 41 per cent of potash and 11½ per cent of nitrogen, showing it to be nearly pure nitrate of potash. On the plots receiving the nitrate of potash 8.2 pounds of potash was applied and 2.3 pounds of nitrogen as nitrate. The dissolved bone contained 28. per cent. of available phosphoric acid, so that plot No. 1 received 6.7 pounds of phosphoric acid. Sulphate of potash contained about 50 per cent. of potash, so that plot No. 2 received 8 pounds of potash. The double carbonate of potash and magnesia contained 20. per cent. of potash, so that plot 4 received 9.6 pounds of potash. As plot 5 received the same amount of nitrate of potash as plot No. 1 it received 8.2 pounds of potash and 2.3 pounds of nitrogen as nitrate. The ten pounds of nitrate of potash were applied to plot 3b after it was seen that without the use of some fertilizer the crop would be a total failure, in the hope of demonstrating the fact that even after the tobacco had made a poor start it could be greatly improved by the addition of a quick responding commercial fertilizer.

The season was a fair one for tobacco so far as the weather was concerned but the tobacco worms were unusually destructive. Our field notes show that from appearance the tobacco on plots 1 and 5 was the best,

followed closely by 4 and 2. The tobacco on 3a was almost worthless, the plants failing to grow more than ten inches high. The application of ten pounds of nitrate on 3b on July 24th, soon had a marked effect on the appearance of the tobacco, but the growth had been too much stunted to produce good tobacco.

The stand was almost perfect on all of the plots, therefore no correction is made for the few missing hills found in the plots. The tobacco was grown in rows three feet apart and the plants were set two feet apart in the rows.

The following table shows the kind and amount of fertilizer used and the yield of tobacco calculated per acre for each plot:

Table I. TOBACCO—Test of Fertilizers.

No. Plot.	Fertilizer Used.		Yield of Tobacco in lbs. per acre.				
	Name.	lbs. per acre	Long Red.	Short Red.	Lugs	Trash	Total
1.	Dissolved Bone..... Nitrate of Potash ..	240 200	530	260	265	240	1295
2.	Sulphate of Potash..	160	350	205	140	265	960
3b.	Nitrate of Potash applied July 24.....	100	100	120	100	260	580
3a.	No Fertilizer.....		0	200	100	200	500
4.	Carbonate of Potash and Magnesia.....	480	215	195	335	315	1060
5.	Nitrate of Potash..	200	395	195	300	310	1200

The yield of plots one and five and even four and two is satisfactory, indicating as the results of last year did, that by applying potash fertilizer, and especially potash with nitrogen, on our land, we can produce a satisfactory yield of tobacco. The quality of tobacco raised, however, for two years in succession is not of the highest grade. Last year the leaves were not only short but

the tobacco was deficient in body and the color was off. This year our tobacco was better, the body good, the color fair, but the leaves were short, but the proportion of trash, lugs and inferior grades was so great that the crop must be considered of inferior quality.

Notes On Tobacco Worms, from Observations Made In 1896.

BY H. GARMAN, ENTOMOLOGIST AND BOTANIST.

Probably not oftener than once in a half century do the tobacco worms become as abundant as they were in the summer of 1896. They were present on both tobacco and tomato in myriads, and proved so destructive that some fields of tobacco were abandoned, and in the fall presented only a wilderness of stems and midribs of leaves. In such fields as many as five worms, representing both species, were frequently observed on a single plant. Their advent was so sudden that before the seriousness of the outbreak was realized, tobacco that had been the pride of its owner, and showed scarcely a mutilated leaf, was severely injured. It was near cutting time when they became most abundant, and some growers preferred to cut their tobacco as the best means of

saving it. On the "suckers" in fields and on abandoned tobacco the worms remained until frosts killed the plants. Large numbers of both species were collected in October, from such tobacco, and they were observed in fields until October 12.

The good work done by insect parasites and by skunks in destroying the worms leads me to think they will not be as abundant next season. Yet from the numbers that pupated in our Station Vivarium, there can be no doubt but that some pupæ are now in the soil of last season's tobacco fields. Fall and winter plowing would break up the earthen cells in which they lie and expose them to the weather and their enemies. Of course tobacco planted in 1897, on land which was badly infested in 1896, is more likely to suffer than it would be on new land, but since the moths are strong fliers, they are likely to find their way in larger or smaller numbers to tobacco planted anywhere in Blue Grass Kentucky.

The outbreak, like many other misfortunes, taught its own lesson, and doubtless many of those who suffered will be better prepared for such emergencies in the future.

THE EFFECT ON TOBACCO WORMS OF VARIOUS QUANTITIES OF PARIS GREEN.

In an earlier bulletin attention was called to the fact that young worms are more easily killed than old ones, and that weaker mixtures than those sometimes used in the field could be trusted to destroy worms if applied at the proper time. In order to satisfy any doubts on this point that might arise in the minds of those who use the arsenite on their tobacco, worms were kept in the Vivarium of my Division last summer and fed tobacco treated with mixtures of Paris Green and water, rangeing in strength from one pound in forty gallons to one pound in one hundred and fifty gallons. The results of these

tests are given in the three tables following, the tables constituting equivalent series, and alternating numbers, beginning with No. 1, denoting treated worms, while even numbers (2, 4, 6, etc.,) denote untreated worms and constitute checks on the others.

For every mixture three small worms were used in one lot and three large ones in another, so that, including all three series and both large and small worms, eighteen examples were treated with each mixture and eighteen others were kept as checks, making a total of 252 worms in all. By small worms is meant those from one-third to one-half grown. We found it impossible to make up these lots of worms of exactly the same size. The large worms proved in some cases to be ready to go into the ground for pupation, and some of those that are noted as persisting until September 19, and finally pupating, probably did not eat the poisoned food at all.

The tables speak for themselves, but it may be well to call attention to some of the general conclusions to be drawn from them.

1. They confirm the conclusion previously reached that young worms are more quickly killed than old ones. Thus the average duration after treatment of lots of small worms was 4.43 days, while the treated lots of large worms persisted on an average 12.33 days.

2. The length of time required to kill worms increases as the strength of the mixture used diminishes. The average duration of all the lots of worms, of all sizes, treated with a mixture consisting of one pound of Paris green in 40 gallons of water was four days, while the average for the lots which had been treated with the mixture consisting of one pound in 150 gallons is 14.17 days. But it must be added that the increase in the averages is not a regular one, and that some of the lots treated with weaker mixtures lasted longer than others,

the worms of which ate more of the poison. In a general way, however, the averages show that worms of all ages fed weak mixtures live longer than those fed strong ones.

3. When worms are young, weak mixtures will serve as well as stronger ones. The average duration of lots of young worms treated with mixtures varying from one pound of Paris green in forty gallons of water to one pound in 100 gallons was 4.11 days. The average of the lots of young worms fed mixtures varying in strength from one pound in 120 gallons to one pound in 150 gallons was 4.67 days, only a trifle greater. The increased time required to kill the worms does not consequently count against the weak mixtures used in these experiments when the young worms are considered alone. That it is of more importance when dealing with large worms, is shown by the fact that the difference in average durations of lots of large worms at the two ends of the series is much greater than in the case of the lots of small worms. Thus large worms fed mixtures varying in strength from one pound in forty gallons to one pound in 100 gallons, persisted, on an average, 8.44 days, while lots fed mixtures varying from one pound in 120 gallons to one pound in 150 gallons averaged 15.25 days.

TABLE I.—SHOWING EFFECT OF Various Mixtures of Paris Green. Tests Started

No.	Paris green and water.	Size of worms.	August 26.	August 27.	August 28.
1	1 lb to 40 gals.	Small	1 alive.	1 alive.	None alive .....
2	None.....	Small	3 alive.	3 alive.	2 alive .....
3	1 lb to 40 gals.	Large	3 alive.	3 alive.	2 alive.....
4	None	Large	3 alive.	3 alive.	2 alive.. .....
5	1 lb to 50 gals.	Small	3 alive.	2 alive.	2 alive.....
6	None.	Small	3 alive.	3 alive.	3 alive.....
7	1 lb to 50 gals.	Large	3 alive.	3 alive.	3 alive.....
8	None	Large	3 alive.	3 alive.	2 alive.. .....
9	1 lb to 100 gals.	Small	3 alive.	3 alive.	2 alive.....
10	None.	Small	3 alive.	3 alive.	3 alive.....
11	1 lb to 100 gals.	Large	3 alive.	3 alive.	3 alive.. .....
12	None.	Large	3 alive.	3 alive.	3 alive.. .....
13	1 lb to 120 gals.	Small	3 alive.	3 alive.	None alive .....
14	None.	Small	3 alive.	3 alive.	2 alive.. .....
15	1 lb to 120 gals.	Large	3 alive.	3 alive.	3 alive.. .....
16	None.	Large	3 alive.	3 alive.	1 alive, 2 missing
17	1 lb to 130 gals.	Small	2 alive.	2 alive.	1 alive.....
18	None.	Small	3 alive.	3 alive.	3 alive.. .....
19	1 lb to 130 gals.	Large	3 alive.	2 alive.	1 alive.. .....
20	None	Large	3 alive.	2 alive.	2 alive.. .....
21	1 lb to 140 gals.	Small	2 alive.	1 alive.	None alive .....
22	None	Small	3 alive.	3 alive.	3 alive.....
23	1 lb to 140 gals.	Large	3 alive.	2 alive.	2 alive.. .....
24	None	Large	3 alive.	3 alive.	1 alive, 2 missing
25	1 lb to 150 gals.	Small	3 alive.	1 alive.	1 alive.....
26	None	Small	3 alive.	3 alive.	3 alive.....
27	1 lb to 150 gals.	Large	3 alive.	3 alive.	3 alive.....
28	None	Large	3 alive.	3 alive.	3 alive.. ...

FEEDING TOBACCO WORMS

August 25. Three Worms Used for Each Test.

August 29.	September 1.	September 4.	September 10.	September 19.	No.
.....	.....	.....	.....	.....	1
.....	.....	.....	.....	.....	2
None alive ...	.....	.....	.....	.....	3
2 alive..	.....	.....	.....	.....	4
2 alive..	None alive	.....	.....	.....	5
3 alive..	3 alive ...	.....	.....	.....	6
3 alive.. ...	3 alive....	None alive	.....	.....	7
2 alive..	2 alive..	2 alive...	.....	.....	8
2 alive..	None alive	.....	.....	.....	9
3 alive..	2 alive.....	.....	.....	.....	10
2 alive,1 miss'g	1 alive..	None alive	.....	.....	11
3 alive.. ...	3 alive..	3 alive.....	.....	.....	12
.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	14
.....	3 alive...	2 alive	1 alive,a pupa	....	15
.....	1 alive	1 alive	1 alive,a pupa	.....	16
1 alive..	None alive	.....	.....	.....	17
3 alive	3 alive	.....	.....	.....	18
.....	None alive	.....	.....	.....	19
.....	2 alive	.....	.....	.....	20
.....	.....	.....	.....	.....	21
.....	.....	.....	.....	.....	22
.....	2 alive	2 alive	None alive	.....	23
.....	1 alive	1 alive	None alive	.....	24
.....	None alive	.....	.....	.....	25
.....	3 alive	.....	.....		26
.....	1 alive	1 alive ...	1 alive . ..	N'ne ali'e	27
.....	2 alive	2 alive ..	2 alive .	1 alive...	28

TABLE II.—SHOWING EFFECT OF Various Mixtures of Paris Green. Tests Started August 26, Used for

No.	Paris green and water.	Size of worms.	August 27.	August 28.	August 29.
29	1 lb to 40 gals.	Small	3 alive....	None alive	... .
30	None.	Small	3 alive....	3 alive..	.....
31	1 lb to 40 gals.	Large	3 alive....	None alive	.....
32	None.	Large	3 alive....	3 alive....	....
33	1 lb to 50 gals.	Small	2 alive....	1 alive....	None alive..
34	None.	Small	3 alive....	3 alive..	3 alive.....
35	1 lb to 50 gals.	Large	2 alive....	None alive	.....
36	None.	Large	3 alive....	3 alive....	....
37	1 lb to 100 gals.	Small	3 alive....	2 alive...	None alive..
38	None.	Small	3 alive....	3 alive....	3 alive.....
39	1 lb to 100 gals.	Large	2 alive....	2 alive...	2 alive.. ...
40	None.	Large	3 alive....	3 alive..	3 alive.. ...
41	1 lb to 120 gals.	Small	1 alive....	None alive	.....
42	None.	Small	3 alive....	3 alive..	. ....
43	1 lb to 120 gals.	Large	3 alive....	1 alive...	1 alive.....
44	None	Large	3 alive....	3 alive..	3 alive.....
45	1 lb to 130 gals.	Small	3 alive....	2 alive..	2 alive .. ...
46	None	Small	3 alive....	3 alive..	3 alive .. ...
47	1 lb to 130 gals.	Large	3 alive....	None alive	.....
48	None	Large	3 alive ,..	3 alive...	... .
49	1 lb to 140 gals.	Small	3 alive....	2 alive....	2 alive .. ...
50	None	Small	3 alive....	3 alive....	3 alive .....
51	1 lb to 140 gals.	Large	3 alive....	3 alive..	2 alive .....
52	None	Large	3 alive...	3 alive....	3 alive .. ...
53	1 lb to 150 gals.	Small	.....	3 alive....	1 alive .. ...
54	None.	Small	.....	3 alive....	3 alive .. ...
55	1 lb to 150 gals.	Large	.....	3 alive..	3 alive .. ...
56	None.	Large	.....	3 alive..	3 alive .. ...

FEEDING TOBACCO WORMS

Except Nos. 53-56, which were started August 27. 3 Worms Each Test.

August 30.	September 1.	September 4.	September 10.	September 19.	No.
.....	.....	.....	.....	....	29
.....	.....	.....	.....	....	30
.....	.....	.....	.....	....	31
.....	.....	.....	.....	....	32
.....	.....	.....	.....	....	33
.....	.....	.....	.....	....	34
.....	.....	.....	.....	....	35
.....	.....	.....	.....	.....	36
.....	.....	.....	.....	....	37
.....	.....	.....	.....	....	38
1 alive.....	1 alive....	1 alive ...	1 alive.....	None alive	39
3 alive.. ...	3 alive....	1 alive ...	1 alive.....	None alive	40
.....	.....	.....	.....	.....	41
.....	.....	.....	.....	.....	42
1 alive.....	1 alive....	1 alive ...	1 alive.....	None alive	43
3 alive.....	3 alive....	3 alive	1 alive.....	None alive	44
2 alive.. ...	1 alive....	1 alive ...	None alive	.....	45
3 alive.....	3 alive....	3 alive ...	3 alive.....	....	46
.....	.....	.....	.....	.....	47
....	.....	.....	.....	.....	48
2 alive.....	None alive	.....	.....	.....	49
2 alive.....	None alive	.....	.....	.....	50
2 alive.....	2 alive	2 alive	2 living pupæ	.....	51
3 alive.. ...	3 alive ...	3 alive ...	3 alive.....	.....	52
None alive..	.....	.....	.....	.....	53
3 alive.....	.....	.....	.....	.....	54
3 alive.....	3 alive	3 alive ...	3 alive.....	2 lv'g pupæ	55
3 alive.. ..	3 alive .	2 alive ...	2 alive.....	None alive	56

TABLE III.—SHOWING EFFECT OF Various Mixtures of Paris Green. Test Started

No.	Paris green and water.	Size of worms.	August 30.	August 31.
57	1 lb to 40 gals.	Small.	1 alive	1 alive
58	None	Small.	3 alive	3 alive
59	1 lb to 40 gals.	Large.	None alive	
60	None	Large.	3 alive	
61	1 lb to 50 gals.	Small.	1 alive	1 alive
62	None	Small.	3 alive	3 alive
63	1 lb to 50 gals.	Large.	1 alive	None alive
64	None	Large.	3 alive	3 alive
65	1 lb to 100 gals.	Small	1 alive	1 alive
66	None	Small	2 alive	2 alive
67	1 lb to 100 gals.	Large	3 alive	3 alive
68	None	Large	3 alive	3 alive
69	1 lb to 120 gals.	Small	None alive	
70	None	Small	2 alive	
71	1 lb to 120 gals.	Large	None alive	
72	None	Large	3 alive	
73	1 lb to 130 gals.	Small	None alive	
74	None	Small	3 alive	
75	1 lb to 130 gals.	Large	3 alive	3 alive
76	None	Large	3 alive	3 alive
77	1 lb to 140 gals.	Small	2 alive	None alive
78	None	Small	3 alive	2 alive
79	1 lb to 140 gals.	Large	2 alive	2 alive
80	None	Large	3 alive	3 alive
81	1 lb to 150 gals.	Small	2 alive	1 alive
82	None	Small	3 alive	3 alive
83	1 lb to 150 gals.	Large	3 alive	3 alive
84	None	Large	3 alive	3 alive

FEEDING TOBACCO WORMS

August 29. 3 Worms Used for each Test.

September 1.	September 4.	September 10.	September 19.	No.
1 alive	1 alive	None alive		57
2 alive	2 alive	2 alive		58
				59
				60
None alive				61
3 alive				62
				63
				64
None alive				65
2 alive				66
3 alive	3 alive	1 alive	1 living pupa	67
3 alive	3 alive	3 alive	3 alive	68
				69
				70
				71
				72
				73
				74
2 alive	2 alive	None alive		75
1 alive	1 alive	1 alive		76
				77
				78
2 alive	2 alive	None alive		79
3 alive	3 alive	3 alive		80
1 alive	None alive			81
3 alive	3 alive			82
3 alive	3 alive	3 alive	None alive	83
3 alive	3 alive	3 alive	2 living pupæ	84

TOBACCO WORMS ON DRYING TOBACCO.

In the hurry to get tobacco under cover a good many worms are sometimes carried into the barn on the freshly cut plants. Contrary to what would be expected they continue to feed on the leaves for several days afterward and may in this time devour the better part of whole plants. The tobacco dries very slowly and the worms thrive on it, seemingly, for some time, about as well as on the growing plants. Growers familiar with this characteristic of the pest take care ordinarily to have every worm removed before the tobacco is housed. With the tobacco crowded in the barn it would be a very troublesome task to remove worms which had been thus carried in doors, and tobacco smoke has been suggested as a means of compelling them to let go their hold. Burning sulphur has also been suggested. Probably the most effective method would be fumigation with bisulphide of carbon, after shutting closely the barn containing the tobacco. Whether these materials would affect the flavor of the tobacco or not is a question to be settled by experiment. Our first complaint of trouble of this nature was received last summer, though the injury has been known to us for some time. I am informed that smoke made from smouldering wood is sometimes used, but that it is not very effective, and leaves a peculiar flavor with the tobacco that is likely to affect its sale.

TWO KINDS OF TOBACCO WORMS: THEIR DISTRIBUTION.

Throughout the southern States a single species of tobacco worm or horn worm is known to growers of the crop. But a second species very closely related, and in habit, structure and appearance, much like the southern tobacco worm, occurs at the north and in some of the tobacco growing sections displaces the southern species. Ordinarily here in Kentucky the southern

worm only is seen in tobacco fields. But the moth or fly of the northern worm is occasionally observed about flowers, of evenings, and during last summer's outbreak the northern worms became not uncommon in some fields. This is intermediate ground for the two worms and very probably the northern worm is at all times rare in tobacco fields of the South Atlantic and Gulf States.

Its moth seems to occur there constantly, however, in small numbers. Prof. H. A. Morgan, of Baton Rouge, Lousiana, informs me that he has observed some every season for the past eight years.

Prof. Fernald, of the Massachusetts Experiment Station, says that the northern worm (*P. celeus*) is *the* tobacco worm of the Connecticut Valley, and that he has never obtained the southern worm from tobacco at Amherst. The southern worm does occur, however, with the northern species at New Haven, Connecticut, according to observations made by Prof. Thaxter when connected with the Connecticut Station. Dr. Fitch, when State Entomologist of New York, a good many years ago, stated that it occurred in the southern part of his State, whereas the northern worm prevailed elsewhere. Prof. Kellicott, of Columbus, Ohio, finds both species common on tomato, but *P. carolina* in greatest abundance. At Buffalo, New York, he found *P. carolina* rare, and *P. celeus* abundant. From my own experience I can say that the southern worm is common on tomatoes as high up as Central Illinois. But at Lansing, Michigan, Professor G. C. Davis finds the northern worm very common, and has never collected the southern species there. State Entomologist Lugger, of Minnesota, writes from St. Anthony's Park that he has never seen *P. carolina* in that State, and even *P. celeus* is not common. In Canada, too, the southern species is very rare, while the *P. celeus* is sometimes exceedingly common and destruc-

tive. The following with reference to its occurrence there is from a letter recently received from Dr. James Fletcher, Government Entomologist of Canada: "The only locality in Canada where these have been complained of as a serious pest is the extreme southwest part of Ontario Province in the counties north of Lake Erie. About 1887 the caterpillars of *P. celeus* did a great deal of harm in the leaf tobacco plantations of Messrs. Hiram Walker & Co., at Walkerville in Essex county, and the pupæ were collected by the bushel." A few examples of the southern moth have recently been collected at electric light in London, Ontario, Canada, and are now in the collection of the Entomological Society of Ontario. In a letter, which I have been permitted to see, from Mr. J. Allston Moffat, Curator of the Society, to Dr. Fletcher, the former gentleman writes: "I have the pleasure of stating that I have a pair of Canadian *P. carolina* in the collection, taken at electric light in London last summer. I had one of them on exhibition at the last annual meeting, and none of the visitors had ever seen a Canadian specimen before." So that, putting all the observations together, it may be said that the northern limit of the southern worm, so far as its breeding ground is concerned, falls somewhere near the south border of Massachusetts and New York and along the north border of Ohio, Indiana and Illinois. Probably along the Mississippi River and in the immediate vicinity of the Atlantic coast the southern worm extends farther north than at intermediate points, since this is true in general of southern insects and to some extent also of birds and fishes. Similarly the breeding ground of the northern worm may be said to extend southward to the south border of Virginia, Kentucky and Missouri, but in the mountains of both eastern and western North America probably extends farther south. West of the Mississippi River

the two insects are distributed much as they are in the East, as far as I have information on the subject. In Nebraska, Prof. Lawrence Bruner finds the northern species much the more abundant, the southern moth and worm being rarely seen there. Prof. F. H. Hillman, of Reno, Nevada, says that *P. celeus* is by far the commoner in that State, and that he has not taken *P carolina.*

In the lists published by systematic entomologists both species are said to occur throughout the United States, but the statements are based upon observations of collectors of moths, and as the winged insects are strong flyers they are likely to be encountered long distances from their normal breeding grounds. The species to which the technical name *Phlegethontius carolina* is applied is unquestionably in the main southern in distribution, and outside our limits occurs in Mexico, South America and in the West Indies. In his notes on Cuban hawk moths (Proceedings of the Entomological Society, of Philadelphia, 5, p. 69), Mr. Grote does not include our northern worm (*P. celeus*) at all, and hence it is to be assumed that it does not occur on that island, or else that it is rare there. It does occur, however, in Florida, for I have just had the privilege of seeing a specimen of the moth collected at Lake City, in that State, by Professor P. H. Rolfs. The moth was sent to me in a miscellaneous collection of hawk moths, in which were three moths of the southern species to this one example of the other, but probably the southern species predominates in Florida much more decidedly than these numbers indicate.*

*Since the above was written a letter has been received from Prof. Rolfs, stating that in his collection there are six times as many *P. carolina* as of *P. celeus.*

LIFE HISTORY OF THE SOUTHERN WORM.

Observations made on the worms this season tend to confirm conclusions (see Bulletin 63, p. 78) reached in previous years as to the number of annual broods. The young worms appeared before the plants were transplanted and did some mischief in the seed beds. On June 20, I saw on the place of Mr. Paul Lansing, of Versailles, in Woodford county, worms that were nearly two-thirds grown. Doubtless these represented the first brood of the season. The moths I did not see at this time, but in 1889 noted them as abroad on June 8.

The latest brood was observed as young worms on the growth of new leaves that appears after the tobacco crop is removed. On October 12 they were common, but I do not think this brood matured, owing to frosts that occurred subsequently.

I have seen no description of the egg of the southern worm. It is shortly oval, with the two ends alike. Specimens preserved in alcohol measure 0.06 inch in length*. It is smooth and translucent so that the contents can be seen clearly through the egg-coat.

THE DIFFERENCE BETWEEN THE NORTHERN AND SOUTHERN TOBACCO WORMS.

The opportunity to collect large numbers of both northern and southern tobacco worms during the season of 1896 enabled me to make comparisons between them, and I present below characters by which they may be distinguished. No attempt is made to give a full description, only such features of color and structure being employed as will serve to separate the two species.

*An example before me, collected September 12, measures 1.5 mm. in length and 1.3 mm. in width.

Body of worm clothed with soft down; with seven oblique lines on each side. Pupa more coarsely punctured than in the next; tongue-case shorter. Moth sooty brown, with a cluster of white dots at base of fore wing:

The Southern Tobacco Worm (*Phlegethontius carolina*).

Body of worm not downy, smooth and shining in large examples; with eight V-shaped marks on each side Pupa smooth; tongue-case longer than in the preceding species. Moth ash-gray. Base of fore wing without white dots:

The Northern Tobacco Worm (*Phlegethontius celeus*).

The Southern Tobacco Worm.

The Worm.—Body clothed everywhere with fine soft down, except in very young examples, in which the head and body are minutely roughened. Ground color green, with seven obliquely placed whitish lines on the sides, the first of which begins above the second breathing pore, and extends thence upward and backward nearly to the hind margin of the body division bearing the third breathing pore. The last line begins above the next to the last pore and extends upward and backward to the base of the horn. Each white line is edged above by a black one made up of a series of small dashes. Head green, without marks. Upper lip without marks. Mouth parts of large examples black at tips. Jointed legs, pale greenish, with a black ring at the base of each division. Neck plate on the body division just behind the head, green in color. Horn curved, red. No black plates at hind end of body.

These are the most striking distinctive characters of this worm as compared with the nearly related northern worm (*P. celeus*). Considerable variation in the general color has been observed. Examples sometimes appear that show a tendency to melanism, the black markings being greatly extended, and even giving the prevailing hue in extreme examples. A specimen illustrating this

tendency is before me. The black edging of the oblique lines is wide and continuous; each narrow body ring (annulus) is continuously edged with black; a narrow median black line extends along the back to the base of the horn; the sides below the spiracles are extensively black, and the black rings of the jointed legs are much wider than in normally colored examples. In some very large examples the oblique white lines become very faint after they pass the boundaries of the divisions on which they originate, and are continued on the succeeding segments only by their black edgings.

The Pupa.—Rather stout. Tongue-case short and thick. Outline of wing pads not angled above, a little concave, then quite regularly rounded to extremity. Abdominal segments roughened at base (closely punctured). Tip of abdomen deeply and coarsely punctured above. The pupa is much like that of the related species in other respects.

The Moth.—General color sooty brown (fuliginous). Fore wings with a cluster of spots at base, and a single small dot at the middle near the front margin, pure white. Fringe of outer margin alternately white and black in sharp contrast. An obscure whitish dentate line starting at the outer angle and extending forward toward the apex of the wing. Outer angle not pronounced, rounded. Hind wings sooty brown in the main. Outer third more or less overlaid with ashen scales, forming a couple of obscure cross-bands. Inner two-thirds of wing marked with black and grayish white in more or less complete cross-bands. The outermost band is black, and limits the dusky outer third of the wing; then follows a whitish band; within this is a pair of characteristic black bands, completely fused in some examples, but more commonly separated by an obscure and incomplete pale band; next comes another pale band

which does not reach the inner margin, and is generally cut in two by a black extension from the inner band of the pair, which extension joins the fourth black band, situated some distance from the body. The base of the wing gray, with an obscurely outlined black spot. Legs sooty brown, annulate with pure white. Head and thorax above brown, with an olive cast. Abdomen marked with six orange-yellow spots on each side, the foremost being squarish, while the very small hindmost is round. Space between the two series olivaceous, with an obscure black median line.

The Northern Tobacco Worm.

The Worm.— Body smooth and shining, not downy. Young with the skin roughened everywhere above by small conical tubercles. General color varying from glaucous green to deep livid, or umber-brown. Conspicuously marked on each side with a series of eight yellow or greenish white Vs, pointing forward, and each one embracing a breathing pore in its angle. The first includes the second spiracle. The last includes the ninth spiracle, is smallest, and its arms are curved so as to enclose its spiracle more completely. Upper arms of the Vs. represent the oblique lines on the side of the southern worm, but differ in not being edged above with black, and in terminating abruptly at the hind edge of the segments on which they originate. The lower arms of the Vs are not represented in the southern worm. Extending forward from the front V is a yellow stripe which reaches nearly to the head. The upper arm of the next to the last V reaches the base of the horn. With evident round or oval, yellow or pale green dots over much of the body. Head green, or brown, generally with a pair of black lines, one on each side, beginning at the side of the mouth and extending well

up on the occiput, where each may join a brown patch which occupies much of the side of the head behind. Head sometimes without the cheek patch, sometimes uniform green, like the head of the southern worm, sometimes with the lines and cheek patches combined so that the whole side of the head is black. Labrum and clypeus each with a brown band; other mouth parts extensively black from the tips. A black neck plate on the segment behind the head. Jointed legs black, more or less evidently ringed with white, rarely uniform green. Fleshy legs marked with brown outside, those of the four anterior pairs with a narrow basal band, the hindmost with a large external triangular plate. Horn black and not so much curved as that of *P. carolina*, often quite straight, or even slightly bent upward. A large triangular brown, or black, plate at rear end of body below the horn.

This worm is much more variable than the southern species, but can be recognized by the combination of characters given above. Green specimens may lack the black of the head; and the neck plate, fleshy legs and caudal plate may be green; but in such examples the smooth skin, the V-shaped marks of the side, the black jointed legs and black horn, will decide the question of species. The pale dots are also sometimes largely wanting, but are generally in themselves sufficient for the recognition of this worm, being rather large, and rendered conspicuous from their contrast with the ground color; in large examples they are most abundant on the back, where they are ranged in cross rows; on the region of the side occupied by the V-shaped marks they may be largely wanting, but appear again on the sides of the fleshy legs and on the body beneath.

The Pupa.—The pupa is more slender than that of the southern worm, and much smoother, the puncturing

at the bases of the divisions of the body and at its hind extremity being much finer and less deep. The outline of the wing-pad is evidently angulate in this pupa, in agreement with a peculiarity in the shape of the wing of the adult. Tongue-case longer than in the southern worm and not so thick; its tip touches the body at about a third of the length from the head, while in the pupa of the southern worm its tip extends but little past the front fourth of the length.

The Moth.—General color ash-gray. Fore wings ash-gray at base, without white spots. No white dot at middle of wing, this mark represented by a gray dot encircled with black, which does not contrast with the color of adjacent parts. Fringe of outer margin without white. An evident whitish line begins in an enlargement at the angle and extends forward, parallel with the edge, towards the apex of the wing, but terminates abruptly before reaching it. Outer angle of fore wing decided. Basal two-thirds of hind wing largely light ash-gray, the middle of the wing crossed by two sharply dentate black lines, which represent the more or less fused pair on the wing of *P. carolina*. Outer third of hind wing largely ash-gray, this area limited within by a wide curved band of black. Head and thorax above ash-gray. Abdomen on middle above ash-gray, with an evident narrow median black line. Orange spots on side five in number, less elongated transversely and more rounded than in the related species. Legs gray, cross-banded with whitish above.

SOME OF THE LITERATURE RELATING TO THE TWO WORMS.

The figures of these insects published in Harris's Insects Injurious to Vegetation (Flint's edition) have apparently served to mystify some of our later writers as to the differences between the two species. The figures

of the worms appear to have been transposed. Figure 142, p. 321, published and explained as the larva of the northern worm, *P. celeus*, really represents the southern worm (*P. carolina*), while figure 146, p. 322, of the same work explained as the larva of the southern worm, represents instead a young worm of the northern species (*P. celeus.*) Figure 147, of the same author, representing, as explained, the pupa of *P. carolina*, looks rather more like a pupa of *P. celeus*.

Harris's figure is reproduced in C. V. Riley's first Missouri report, p. 95, as the larva of *P. celeus*. It occurs again in Miss Treat's Injurious Insects, p. 87, and is used on page 273 of Dr. Packard's Guide to the study of insects. On page 274 of the latter work is an outline copy of Harris's figure 146, explained as that of the larva of *P. carolina*, which species it does not properly represent. The same figures have been copied repeatedly by recent writers in various publications, including Station Bulletins. The two worms are discriminated and described accurately but briefly in Dr. Clemen's Synopsis of the North American Sphingides (Journal, Academy of Natural Science of Philadelphia, 1859, pp. 165, 166). The same descriptions are republished in Dr. J. G. Morris's Synopsis of the Described Lepidoptera of North America, 1862, pp. 189, 190. Dr. Asa Fitch also knew the two species, as is evident from his account of the northern species in his ninth report as State Entomologist of New York (1865). Dr. J. A. Lintner's descriptions of varieties of the northern worm (Proceedings of the Entomological Society of Philadelphia, Vol. iii, 1864, p. 648) are unquestionable contributions to a knowledge of this species. But with reference to the black variety there referred to, I must say that among the many specimens observed by me, several hundred of which were kept in the Station Vivarium until they

pupated, I did not find a single worm absolutely black, though some were so dark in color that they would have given a casual observer the impression that they were black.

It is uncertain whether or not the description purporting to be from the larva of *P. celeus* in Thomas G. Gentry's article in the Canadian Entomologist, vol. vi., 1874, p. 88, really pertains to that species. The variety described as normal certainly does not agree in color with the average worm from Kentucky, and the oblique lines extending over two segments of the body are strongly suggestive of the southern worm, in which these lines do so extend, as already noted. Whatever they may be, the author's explanation of the extreme variations, such as *P. celeus*, presents as due to the character, or condition, of the food eaten, cannot be accepted for this particular species, since these variations occur among individuals feeding either upon tobacco, or tomato; and all the variations I have observed from uniform green to deep umber-brown have been noted upon plants of the same plot of ground, extremes sometimes occurring even on the same plant. Moreover, it is not the effect of food upon immature worms, for I have had both green and brown worms which went into the ground for pupation. The colors of both worms, however, become darker as cold weather comes on, the tendency to melanism becoming very pronounced at the last. The same changes are to be observed among other insects, such as katydids and butterflies, and seem to me to be due to the lowered temperature rather than to food. Similar changes are to be observed in the colors of persistent blooming plants, our parasitic broom-rape (*Phelipæa ramosa*) illustrating the change very well. During the heated period of July and August its flowers are very pale, but in September, and very

early spring, examples grown by me, and others observed in the field, bear flowers of a very decided blue color. I assume that the differences observed in the flowers of plants which range widely in vertical distribution are to be explained in the same way, and that the greater variability and brighter average colors of the northern tobacco worm as compared with the southern, are the impress upon it of the sharper contrasts of temperature to which it is, as a species, subjected.

ENEMIES OF TOBACCO WORMS.

The same insect parasites appear to attack both species, and this holds true also of fungus parasites.

The common species here in Kentucky is the four-winged fly (*Apanteles congregatus*) which changes to pupæ in the small white cocoons often seen attached to the skins of worms. At times the southern worm is so badly infested that few escape for pupation. The same parasite was found by me last fall on the northern tobacco worm.

When the little white cocoons are removed from the back of a worm and kept in a bottle the parasites can be secured when they emerge. They come out indoors during the fall and winter. With the true parasite mentioned above, one often finds a great many other small insects belonging to the same insect order and representing two distinct species*. These are thought to be secondary parasites, that is, parasitic on the Apanteles, but I am not aware that any careful observations are on record as to the exact relation they sustain to each other and to the worms. However this may be, among them large numbers of worms are destroyed in the fall, sometimes as much as 75 per cent. being infested.

*The names of these two insects are *Mesochorus luteipes* and *Hypopteromalus tabacum*.

The eggs of the southern worm are destroyed by a very minute insect which undergoes all its changes within the egg-shell of its host. Professor C. V Riley gave it the name *Trichogramma pretiosa* (Canadian Entomologist, xi., 1879, p. 161). Mr. W. H. Ashmead also describes a small egg parasite (*Telenomus sphingis*) in an article on the insects injurious to garden crops in Florida (Bulletin 14, Division of Entomology U. S. Dep. Agr., p. 18), and again, with an outline figure, in his Monograph of North American Proctotrypidæ, p. 155, pl. vii, fig. 7.

A large parasite, a fly* somewhat resembling the house fly, was observed many years ago to destroy the worms (See C. V. Riley's 4th Missouri Report, p. 129, footnote, and also his "Potato Pests," 1876, p. 96.) I have not observed it thus far at Lexington, but very probably it occurs in this State.

One of the most useful enemies of the tobacco worms here in Kentucky is the common skunk *Mephitis mephitica*. When the worms begin to go into the ground in the latter part of summer, he visits tomato patches and tobacco fields at night and devours worms and pupæ in great numbers. The evidence of his visit is to be seen in numerous small pits bearing marks of his claws, which he digs in unearthing his prey, together with occasional remnants from his feast. I have seen ground on which the worms were abundant

*The fly bred by Dr. Riley was referred by him at first to the genus Masicera, but in his "Potato Insects," p. 96, he mentions it under the name *Exorista leucaniæ*. Dr. L. O. Howard, Entomologist to the National Department of Agriculture, informs me that Riley's fly was doubtless *Sturmia inquinata*, basing his decision on an examination made by Mr. Coquillett, of the Department, of specimens donated by Riley to the National Museum. Two additional flies (*Sturmia trifida* and *Winthemia 4-pustulata*), Dr. Howard writes me, have been bred from the southern tobacco worm at the Department of Agriculture, one of which (*S. trifida*) attacks also the northern worm.

where there was probably not a square yard in which this mammal had not made one of these pits, and probably but few of the worms escaped. He is said to do some little mischief at times by pulling down tobacco leaves so as to reach the worms.

Both worms are subject to the attacks of a fungus (*Empusa grylli*), similar to that which at times kills house flies and leaves them sticking to walls. In the Annual Report of the Connecticut Experiment Station for 1890, p. 96, Dr. Roland Thaxter states that he observed in the summer of 1890, in a field near New Haven, a destructive epidemic in progress, which resulted in the destruction of so large a proportion of the worms that but little injury was done by them, whereas the preceding season they had stripped the leaves from tomatoes grown on the same land. He observed that the worms just before death assumed a milky hue, and became greenish yellow after dying. The fungus appears on the skin soon afterward, but it is so inconspicuous that it would be likely to escape observation unless the nature of the disease is suspected and examination made with reference to it. The shriveled and blackened remains of dead worms were left in numbers clinging to the plants. The disease was found easy to propagate on young worms.

I have sometimes observed dead and blackened worms clinging to the plants, head down, by means of the hooks on their fleshy legs, and presume they were killed by the same fungus, since it is a common parasite of such pests as the fall web-worm, in Kentucky.

July 11, 1889, I observed on some plants which had been left in frames near the Station Building two worms attached by the hindmost pairs of false legs, and with the front two-thirds of the body hanging backward and downward. One was dead, with the front two-thirds of the body blackened and swollen, the remainder partly green

and partly discolored. The other example was still alive, but was suspended like the former and was very weak. At that time the Station possessed none of the literature relating to parasitic fungi, so that it was impossible to decide what the disease was due to. But from notes then made it seems probable it was caused by attacks of the fungus mentioned by Professor Thaxter.

From these notes the following is quoted: I believe the dead are affected with a fungus disease (Entomophthora possibly), and this is supported by the presence on the front part of the body of a gray bloom, probably the fruiting part of the fungus. The following is a description of the larva: Length two inches. Anterior inch and a quarter of length dull black, with a few yellow blotches on the two somites next to the thorax. Swollen so as to obscure the segments and to cause the head and legs to project rigidly. A faint whitish bloom apparent on head and thorax and about bases of legs. Posterior part of body showing original colors in part, but the two hindmost segments badly discolored. This part of body not rigid like the front part. Fluids of body swarming with bacteria, actively motile, one Bacillus in doubles of large size. These probably post mortem. Fluids also contain great numbers of brownish bodies of irregular size, which are probably parts of some parasitic fungus. They are generally not quite circular in outline, often with an indentation on one side. Occasional threads consisting of numerous segments seen.

The worms are subject also to the attacks of the chinch bug fungus (*Sporotrichum globuliferum*) as was observed in the Station Vivarium during the past summer, where examples sometimes became infected spontaneously. These worms usually died with their feet clasping a twig and with the body held up rigidly, in positions often assumed by the living worms. After their death the skin became

completely covered by a fine snow-white powdery coat, as shown in the figure presented herewith.

It is not improbable that these fungus enemies can be utilized in a practical way for the destruction of the tobacco worm. The species of Empusa are rather difficult to manage as a rule, but the chinch bug fungus grows very readily on corn meal charged with meat infusion, and can be easily applied by spraying it in water. It remains to be seen if such applications would prove effective in the field.

The exposed manner of life led by the worms is not favorable to its successful use as an agent for their destruction except when the weather is very moist.

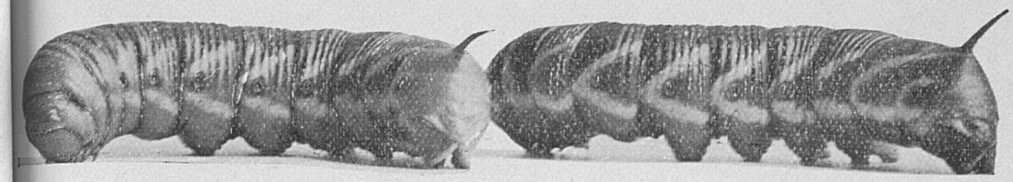
EXPLANATION OF THE FIGURES.

Figure 1.—A and B, representing two dark colored examples of the northern worm; C, a younger worm of the dark variety, with distinct yellow dots; D, green variety of the northern worm; E, young southern tobacco worm, in process of moulting skin; F, a southern worm, with cocoons of small 4-winged insect parasite on back and sides; G, a southern worm which has been killed by the chinch bug fungus. Natural size. Photographed by H. Garman.

Figure 2.—Pupæ of tobacco worms. A, pupa of southern worm; B, pupa of northern worm. Natural size. Photographed by H. Garman.

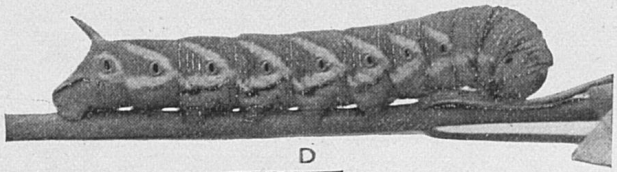
Figure 3.—The moth of the southern worm. Natural size. Photographed by H. Garman.

Figure 4.—The moth of the northern worm. Natural size (representing a rather large specimen, however). Photographed by H. Garman.

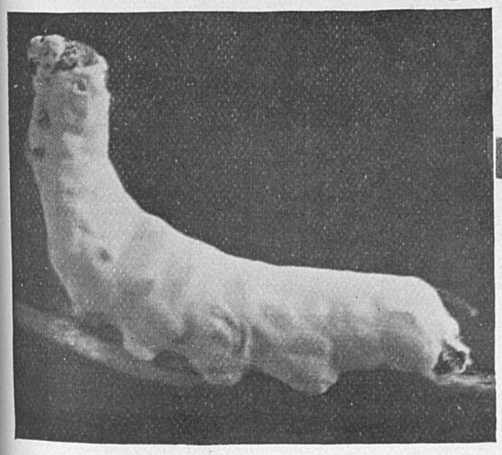


A B

C

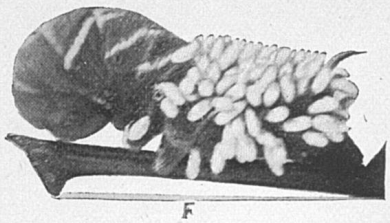


D



G

E



F

FIG. 1.

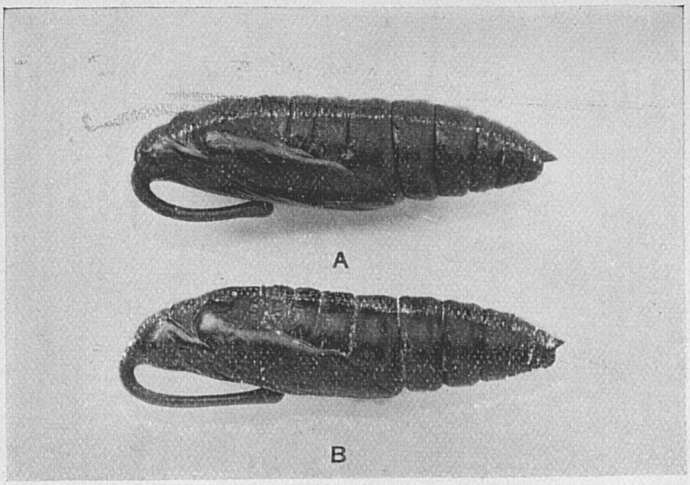


FIG. 2.

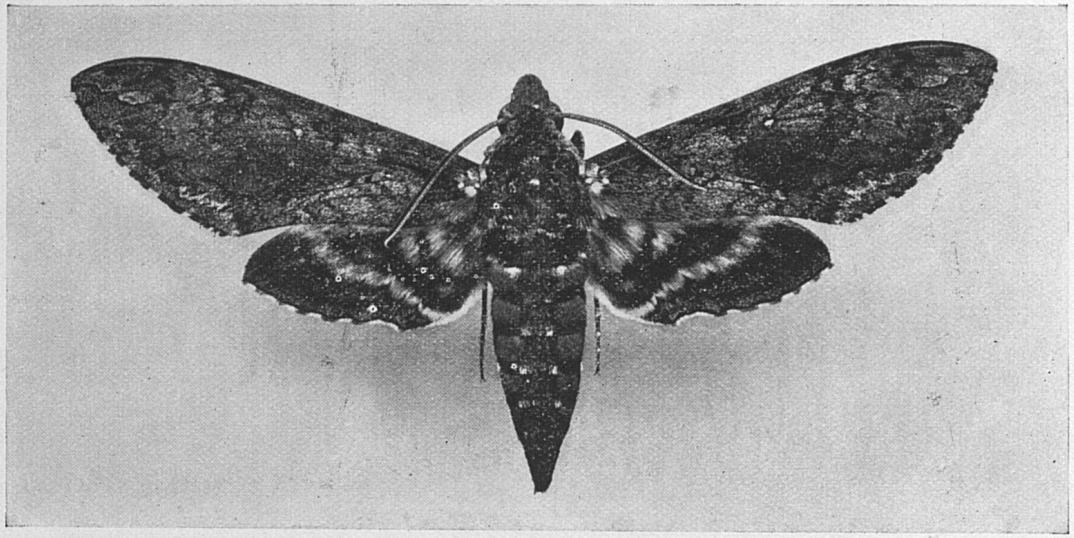


FIG. 3.

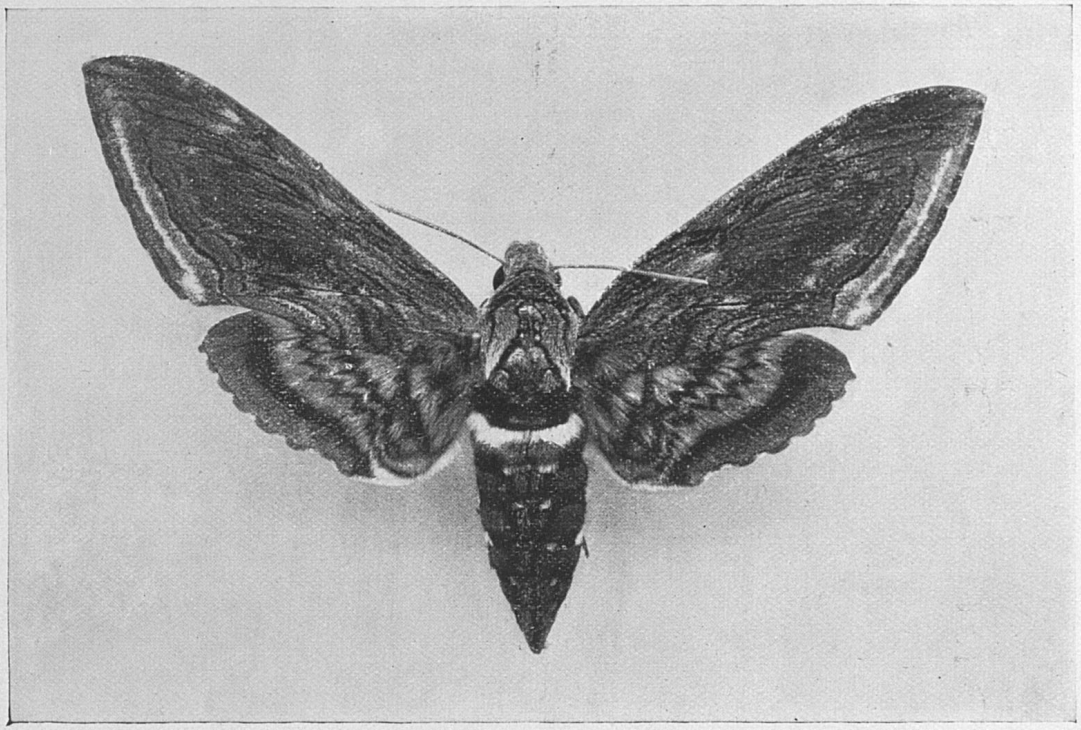


FIG. 4.

Notes on Several Tobacco Insects and on Two Imperfectly Known Diseases of Tobacco.

BY H. GARMAN, ENTOMOLOGIST AND BOTANIST.

THE SPINED TOBACCO BUG
(*Euschistus variolarius*).

Occasional plants in tobacco fields are at times observed to have become suddenly wilted, the leaves hanging limp much as if the stalk had been severed. After a time they recover again, and beyond a temporary check on their growth appear to have suffered but little injury. If such plants are searched carefully while still wilted, a flat brown bug with each side of the body produced into an angle, or sharp spine, will be found on the stalk among the bases of the leaves. It is very shy, however, and keeps out of sight, hence any brisk movement about the injured plants is likely to cause it to drop to the ground and conceal itself. It is one of the puncturing kind, and carries a slender beak held up against its body between the bases of the legs.

My attention was called by Dr. Spurr, of the Experiment Station, to such wilted plants in a plot of tobacco on the Experiment Farm, July 18 of last summer. On searching them I found the majority of the affected plants with one of these bugs on the stem. Those which injured the other plants probably had been previously alarmed and had escaped. Since then the injury has been described to me by other persons, and quite recently I have learned of a case which occurred across the Kentucky river in Clark county. It appears, therefore, to be a somewhat general injury to tobacco in this part of Kentucky, and since the insect is widely distributed in the United States, it probably attacks tobacco in other states. In the case which came under my personal ob-

servation on the Experiment Farm the injured tobacco was grown next a pasture. The tobacco grown elsewhere on the farm was not attacked, and hence it is probable the bugs came in from herbage growing in the pasture. The insects captured by me were, with one exception, adults. The plants were about half grown.

Length of adult bugs from front of head to tips of folded wings one-half inch (13 mm.) From tip to tip of the spines on side of body rather less than a third of an inch (7.67 mm.) Body flat (depressed.) Head flat, rounded in front. Division of body bearing the spines, concavely arcuate before the spine of each side. A large triangular plate between the bases of the wings. Wings folded flat on the back, the thin membranous tips overlapping. Color above drab, pale greenish or yellowish below. Feelers black at tips, the basal two-thirds red.

Several very similar plant-infesting bugs of the same genus occur here, and may easily be mistaken for this one. The spined soldier bug (*Podisus spinosus*), an inveterate foe of young potato bugs, is also like it in a general way, but has a thicker beak, and bears a distinct dash of black in the membranous tip of each front wing.

To prevent the injury it is only necessary to search the wilted plants and remove the bugs, and to keep down weeds, especially thistles and mullein, which are very attractive to such insects, on any unused land which may adjoin tobacco fields.

THE CORN ROOT-WORM ON TOBACCO.

A small green beetle, with twelve black spots on the back, is frequently observed on tobacco leaves, gnawing small round holes. It is the adult of what I have described in earlier publications as the corn root-worm of Kentucky. The grubs feed on the roots of corn, but the adult beetles are very general feeders, attacking tobacco

leaves only as their wanderings bring them to a tobacco field when hungry. They are not to be looked upon as in any way a threatening enemy to this crop.

THE CORN WORM (*Heliothis armigera*) ON TOBACCO.

More examples of this insect have been observed on tobacco this year than ever before. It is quite capable of severe injury to the folded central leaves of growing plants. But it is, above all things, a corn insect in this State, and seems to attack tobacco only when this crop is grown next corn, and then only when the corn becomes so ripe as to be inedible to the worms. In the fall, especially, the worms leave the ripe corn in considerable numbers, and feed upon what tobacco they find growing at that time near them. And since this tobacco is of no value, they do no mischief at this time. Early corn should not be grown alongside tobacco, because of the danger from these worms when the ears become ripe.

THE TOBACCO BUD-WORM (*Heliothis rhexia*).

This worm is very similar to the corn worm when in the grub state, and works on tobacco in the same manner. I was surprised recently to find among a miscellaneous lot of insects, collected at Bowling Green by Miss Price, examples of the adult moth which were labeled as having been reared from worms which eat the seeds of cultivated columbine. In a note with the specimens they are said to cling to the pods in an upright position, where they resemble the follicles.

The same insect was observed last summer eating into the seed pods of tobacco grown in the Vivarium at the Station, the moths having entered through the opened sash and placed their eggs on the pods. An example was confined with a young plant to see where it would place its eggs, but it died without placing any, and I am

disposed to consider the insect a seed eater, like its relative the corn worm, which only occasionally, and probably when deprived of its normal food, attacks leaves of tobacco.

DWARFED TOBACCO PLANTS.

My attention has been called several times to tobacco plants that refuse to grow, though planted on good soil, and with everything seemingly in their favor. Generally they occur in only a part of a field, while all around them are thrifty plants much larger than they, but of the same planting. When taken up the roots were sometimes found to be in a close mass, with little appearance of new growth. Some of these cases are the result of the temporary standing of water about the plants after showers, causing a settling and packing of the soil. This trouble is likely to occur where a part of the surface is depressed below the general level, and especially where the underlying rocks are so near the surface that the rainfall does not readily escape. But the same result appears to come sometimes from the excessive washing of the soil on slopes before the plants have started to grow. This seemed to be the condition of some plants on the place of Mr. Paul Lansing, five miles northwest of Versailles, last spring.

On June 21, in company with Mr. Lansing, I visited his fields and made personal examination of affected plants. They were situated on a slope where there had evidently been a good deal of washing after showers. The plants were small, yellow, feeble, some with no hold on the soil. Some of the plants had the tip of the root turned to one side, and in one or two of those taken up the tip of the top root was turned back toward the surface of the ground. I think this condition of the root was in part responsible for the trouble; for where the soil was not affected by the rainfall this position

would not prove a permanent disadvantage. After the injury became apparent, soil was drawn up about the plants, and they were, at the time of my visit, in better condition, Mr. Lansing said, than they had been some time earlier. Here and there a plant among these small ones was as thrifty as those elsewhere in the field, probably the result of some accident of situation, or to its roots having been so placed that it could better resist the evil effects of washing The soil was in excellent condition about and beneath the plants. On the top of the knoll, where the rains could not shift the soil, the plants were in excellent condition in the main, but on a small area where the surface was depressed, plants were observed in the same condition as were those on the side of the knoll. No trace of insect injury was apparent.

The closest questioning of growers sometimes fails to bring either of these conditions forward as a probable cause of such dwarfing of plants, and possibly there is some enemy yet to be discovered that works on the fibrous roots. The roots often have an appearance of being rotted off at the tips, but I have not seen in any case evidence of gnawing except on the tap root, which is sometimes mined as described in our Annual Report for 1895.

One July 8th, 1896, Mr. Jesse Bryan, of this place, brought to the Station some dwarfed plants which had been taken up very carefully. In the earth about the roots were numerous examples of two small insects commonly regarded as rather scarce. One was *Scolopdrella immaculata*,* the other *Japyx subterraneus*. Both are white,

*This insect is blind, but has eyelike organs on each side of its head. It is interesting as connecting the true insects with the thousand legs and millipedes, being sometimes placed in one group, sometimes in the other. All of the American species, occur according to Dr. Latzel, in Europe also, and the names given by Drs. Packard and Ryder to our species are considered by him to be synonyms of names previously published.

wormlike in general shape, the former with a pair of legs on most of the divisions of its body, while the Japyx may be recognized by the presence of a pair of strong forceps at the hind end of its body. Their abundance was suggestive of a causal relation between their presence and the condition of the roots, but they occur everywhere in damp soil, where they are thought to feed on dead vegetable matter. and have never before, to my knowledge, been charged with injury of this sort.

WHITE SPOTS ON STORED TOBACCO.

Mr. Leslie Combs, of Lexington, called my attention last fall to a peculiar affection of stored tobacco that is, he says, a source of considerable annoyance and loss to growers. Round whitish spots varying from 0.06 to 0.25 inch in diameter appear on the leaves, that mark a change in the texture of the leaf at these places and interfere with the proper manipulation of affected tobacco in the course of preparing it for the consumer. The spots have some resemblance to spots, due to microscopic fungi, that appear on the leaves of grape and other plants, and careful examination shows some tufts of minute threads emerging from the tissue of some of the affected regions, but without spores, and hence not to be determined positively. On most of the diseased places no growth of any sort is apparent. Often the surface is smooth and shining, while frequently a spot is surrounded by a very narrow brown rim.

Recently in conversation with Professor Galloway, of the U. S. Department of Agriculture, I learned that he has been studying the same, or a very similar, affection of tobacco leaves, and considers it the result of drops of water or other matter resting on the leaves. He says further that the spots give the affected leaves a resem-

blance to a desirable tobacco which is imported by our tobacconists for certain uses, and that attempts have been made to have the process of producing the spots artificially, patented.