

TENTH

REPORT

✓
Kentucky Agricultural

Experiment Station,

OF THE

STATE COLLEGE OF KENTUCKY,

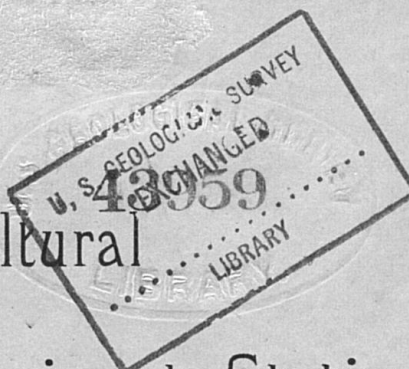
Lexington, Kentucky.

FOR THE YEAR 1897.

1899:

JAS. M. BYRNES, PRINTER,
LEXINGTON, KY.

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Letter of Transmittal.

To His Excellency, HON. WM. O. BRADLEY,

Governor of Kentucky :

Sir—Under the authority of the Board of Control, and in accordance with an Act of Congress, approved March 2, 1887, and entitled "An Act to establish Agricultural Experiment Stations in connection with the Agricultural Colleges established in the several States, under the provisions of an Act, approved July 2, 1862, and of the Acts supplementary thereto," and of the Act of the Legislature of the State of Kentucky, approved February 20, 1888, and entitled "An Act to accept the provisions of an Act passed by the Congress of the United States, approved March 2, 1897, for the establishment and maintenance of Agricultural Experiment Stations in connection with the Agricultural Colleges established by the several States and Territories under Act of Congress, approved July 2, 1862," I herewith submit the Tenth Annual Report of the Kentucky Agricultural Experiment Station.

Very respectfully,

M. A. SCOVELL, *Director.*

Agricultural and Mechanical College of Kentucky.

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STATION OFFICERS.

M. A. SCOVELL, Director.
A. M. PETER, } Chemists.
H. E. CURTIS, }
H. GARMAN, Entomologist and Botanist.
C. W. MATHEWS, Horticulturist.
R. J. SPURR, Superintendent of Field Experiments.
J. N. HARPER, Dairyman.
V. E. MUNCY, Weather Observer.
Miss ALICE M. SHELBY, Stenographer.

Address of the Station,

LEXINGTON, KENTUCKY.

The Kentucky Agricultural Experiment Station

IN ACCOUNT WITH THE UNITED STATES APPROPRIATION.

To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1897, as per Act of Congress, approved March 2, 1887.....\$15,000.00

By salaries	\$10,005.84
Labor	2,382.16
Publications	590.01
Postage and stationery	132.10
Freight and express	61.54
Heat, light and water	276.06
Chemical supplies	107.94
Seeds, plants and sundry supplies ..	242.96
Feeding stuffs	.80
Library	348.32
Tools, implements and machinery ..	78.20
Furniture and fixtures	127.50
Scientific apparatus	339.56
Traveling expenses	75.05
Contingent expenses	92.33
Building and repairs	139.63

Total\$15,000.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Kentucky Agricultural Experiment Station for the fiscal year ending June 30, 1897; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to

have been \$15,000.00 and the corresponding disbursements \$15,000.00, for all of which proper vouchers are on file and have been by us examined and found correct.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress, approved March 2, 1887.

Signed :

H. BOSWELL,

J. B. KENNEDY,

Auditors.



Attest :

JAS. G. WHITE, Custodian.

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ANNUAL REPORT
OF THE
KENTUCKY AGRICULTURAL EXPERIMENT STATION
FOR 1897.

Report of the Director.

The work of the Station has been limited in the main along lines marked out in previous years.

CHEMICAL DIVISION.

In the Chemical Division we have examined and analyzed 488 samples, which may be classified as follows:

Fertilizers	188
Waters	37
Butter—in connection with churn tests of cows	52
Sugar beets and sorghum	122
Dry distillery feed	4
Insecticides and fungicides	9
Rocks, minerals and ores	30
Coal and coke	9
Iron and steel	1
In studying and checking methods of analysis	16
Miscellaneous	20
Total	488

The Study of Methods of Analysis.—The Study of Methods

of Analysis has occupied a considerable portion of the time of the chemists.

Analysis and Inspection of Commercial Fertilizers.—The analysis of commercial fertilizers has been continued. The greater portion of Mr. Curtis' time has been occupied in this work. The funds accruing from this source are not adequate to the work done, and it is hoped that the next Legislature will amend the law, so that a more thorough inspection can be made.

ENTOMOLOGICAL AND BOTANICAL DIVISION.

Under charge of Prof. Garman experiments have been made on tobacco insects, on broom-rape, on the gape worm, on potato scab, on apple rot; and observations have been continued on forage plants with reference to a future bulletin. Prof. Garman, during the summer, inspected all the nurseries of the State, complying in this respect with the provisions of the San Jose Scale law. None of the nurseries were found to be infested by San Jose Scale, but inspection is necessary at least once a year, for it is possible that the disease may be brought to nurseries from purchase of nursery stock from without the State.

Prof. Garman has given considerable attention to perfecting an equipment in apparatus and literature, for work in bacteriology, a subject that is rapidly looming up in agriculture. Some attention has been given to growing several aroma-producing bacteria and introducing them into cream as a means of improving the flavor of butter. One of the many tested seems to have a value for this purpose, and gives a butter that good judges pronounce superior to the best made without the aid of bacteria.

Under Prof. Garman's direction, Mr. Harper, our Superintendent of Dairy Experiments, has devoted some time to special work in bacteriology, and Prof. Garman informs me that he has obtained some interesting results. Prof. Garman has also instructed a class in Entomology in the College.

HORTICULTURAL DIVISION.

The Horticultural work has been confined to a very limited range of subjects. Special attention has been given to strawberries, both upon our own grounds and as produced in the State, and a bulletin is soon to be issued upon this subject. The present year Prof. Mathews desires to give special attention to grape culture.

FIELD EXPERIMENTS.

Under my general supervision, Mr. J. N. Harper has conducted the field experiments during the year. The work may be classified as follows :

WHEAT—	Test of varieties	26
	“ “ fertilizers	10
OATS—	“ “ varieties	28
	“ “ fertilizers	10
POTATOES—	“ “ varieties	250
	“ “ fertilizers	10
	Study of insecticides and fungicides	20
HEMP—	Test of fertilizers	20
CORN—	“ “ “	20
CLOVER—	“ “ “	2
FERTILIZER	experiments on pasture	5
FERTILIZER	“ “ meadow	2
	Tests of strawberries	about 100
	Tests of fertilizers in different parts of State	30

DAIRY WORK.

Under Mr. Harper's immediate supervision, ten cows have been under test as to the effect of feed on the production of milk and butter. The feed tests were: bran versus dry distillery slops. The experiments are completed, but the enormous number of calculations have not yet been computed. Mr. Harper has also had under test cows as to their butter capacity for a week or over. All the cattle associations have asked the Station authorities to make tests of cows for butter seven days or more,

when so desired by owners of thoroughbred cows. Such tests are recognized by all the cattle associations as official tests, and are so recorded in herd registers. Most of the Stations have undertaken this work, including our Station. It probably will have great influence in building up dairies and perfecting breeds, and such work should be encouraged.

OFFICE WORK.

The office work continues to grow, and it necessarily confines me much of the time to the office.

PUBLICATIONS.

We have published during the year six bulletins, as follows:

- | | |
|---------|---|
| No. 66. | Tobacco. |
| No. 67. | The San Jose Scale in Kentucky. |
| No. 68. | Analyses of Commercial Fertilizers. |
| No. 69. | Wheat. <ol style="list-style-type: none">1. Test of Varieties.2. Test of Fertilizers.3. Description of Varieties.4. Treatment of Smut. |
| No. 70. | <ol style="list-style-type: none">1. The Woolly Mullein.2. The Gape Disease of Poultry. |
| No. 71. | Analyses of Commercial Fertilizers. <ol style="list-style-type: none">1. Official Analyses.2. Analyses of Other Samples. |

The reports from the divisions follow, after which the bulletins published during the year are incorporated.

M. A. SCOVELL, *Director.*

Division of Chemistry.

M. A. SCOVELL, *Director*,

Sir:—I submit herewith a report of the Division of Chemistry for the year 1897. Very respectfully,

(Signed) A. M. PETER.

The chemical work in 1897 already published is that pertaining to the fertilizer control published in bulletins 68 and 71. Such other analyses as are of general interest are given herewith. Besides these, many examinations of rocks, minerals, potable waters, etc., have been made, which it is thought useless to publish.

BUTTER.

Butter made at the Station farm in a test of the Jersey cow Bluster's Pip, lasting from January 7 to 27, 1897.

ANALYSES.

Number	3653	3655	3656	3657
Milkings	Jan. 7-10	Jan. 11-13	Jan. 14-15	Jan. 16-17
Fat	83.14	82.64	83.56	82.07
Water	13.80	13.84	13.13	12.95
Salt and Ash ..	2.37	2.71	2.61	3.91
Curd	.69	.81	.70	1.07
	100.	100.	100.	100.
Number	3658	3671	3685	
Milkings	Jan. 18-20	Jan. 21-24	Jan. 25-27	
Fat	80.40	80.49	77.58	
Water	14.99	15.97	18.33	
Salt and Ash ..	3.97	2.80	3.35	
Curd	.64	.74	.74	
	100.	100.	100.	

Butter made at the Station farm in a test of the Jersey cow Princess Marie S., lasting from February 8 to March 11, 1897.

ANALYSES

Number	3690	3701	3702	3704	3714
Milkings	Feb. 8-9	Feb. 10-12	Feb. 13-14	Feb. 15-18	Feb. 19-21
Fat	78.90	80.31	83.66	82.17	81.67
Water	15.72	14.48	12.55	14.06	14.83
Salt and Ash	4.52	4.24	3.01	2.82	2.53
Curd	.86	.97	.78	.95	.97
	100.	100.	100.	100.	100.

Number	3718	3725	3733	3741	3743
Milkings	Feb. 22-25	Feb. 26-28	Mar. 1-4	Mar. 5-7	Mar. 8-11
Fat	82.81	83.31	82.99	81.40	82.37
Water	13.06	14.03	13.50	14.58	14.63
Salt and Ash	3.06	1.79	2.45	3.12	2.11
Curd	1.07	.87	1.06	.90	.89
	100.	100.	100.	100.	100.

Butter made at the Station farm in a test of the Jersey cow Miss Bluster, lasting from March 8 to 31, 1897.

ANALYSES.

Number	3742	3745	3749	3750
Milkings	Mar. 8-10	Mar. 11-14	Mar. 15-17	Mar. 18-21
Fat	82.24	80.27	81.30	80.83
Water	14.07	15.34	13.89	15.25
Salt and Ash . .	2.91	3.47	3.95	3.10
Curd	.78	.92	.86	.82
	100.	100.	100.	100.

Number	3752	3753	3756
Milkings	Mar. 22-24	Mar. 25-28	Mar. 29-31
Fat	82.47	81.21	80.69
Water	13.98	14.66	15.73
Salt and Ash	2.73	3.12	2.80
Curd	.82	1.01	.78
	100.	100.	100.

Butter made at the Station farm in a test of the Jersey cow Virginia, lasting from April 6 to 26, 1897.

ANALYSES.

Number.....	3780	3784	3786
Milkings	April 6-9	April 10-12	April 13-16
Fat.....	80.03	81.95	83.88
Water	17.67	15.04	12.44
Salt and Ash	1.32	2.19	2.63
Curd	.98	.82	1.05
	100.	100.	100.
Number.....	3787	3797	3805
Milkings	April 17-19	April 20-23	April 24-26
Fat.....	81.39	79.69	79.42
Water	16.25	14.63	16.64
Salt and Ash	1.46	4.81	2.86
Curd	.90	.87	1.08
	100.	100.	100.

3716. Butter made from sweet separated cream of the morning's milk of the Station herd, February 23, with the addition of a little phosphoric acid.

ANALYSIS.

Fat	82.75
Water	14.31
Salt and Ash	2.18
Curd	.76
	100.

Butter made at the Station farm in a test of the Jersey cow Imperial Pansy Pogis, lasting from May 11 to June 21, 1897.

ANALYSES.

Number	3844	3845	3847	3848
Milkings	May 11-13	May 14-17	May 18-20	May 21-24
Fat	81.72	81.25	79.72	82.25
Water	14.60	14.94	16.10	14.37
Salt and Ash ..	2.85	2.84	2.79	2.56
Curd	.83	.97	1.39	.82
	<u>100.</u>	<u>100.</u>	<u>100.</u>	<u>100.</u>

Number	3851	3852	3854	3859
Milkings	May 25-27	May 28-30	June 1-3	June 4-7
Fat	80.92	81.81	76.98	81.14
Water	15.06	14.04	14.90	14.37
Salt and Ash ..	2.92	3.47	7.26	3.50
Curd	1.10	.68	.86	.99
	<u>100.</u>	<u>100.</u>	<u>100.</u>	<u>100.</u>

Number	3862	3875	3877	3883
Milkings	June 8-10	June 11-14	June 15-17	June 18-21
Fat	80.49	82.92	79.14	83.32
Water	15.15	13.68	16.70	14.53
Salt and Ash ..	3.46	2.59	3.20	1.43
Curd	.90	.81	.96	.72
	<u>100.</u>	<u>100.</u>	<u>100.</u>	<u>100.</u>

Butter made at the Station farm in a test of the Jersey cow, Nannoonan, lasting from June 2 to June 22, 1897.

ANALYSES.

Number	3855	3860	3872
Milkings	June 2-5	June 6-8	June 9-12
Fat	79.90	82.60	81.07
Water	15.55	13.73	15.04
Salt and Ash ..	3.77	2.80	3.14
Curd	.78	.87	.75
	<u>100.</u>	<u>100.</u>	<u>100.</u>

KENTUCKY AGRICULTURAL EXPERIMENT STATION. xvii

Number.....	3878	3881	3882
Milkings	June 13-15	June 16-18	June 19-22
Fat	81.45	81.78	82.88
Water	14.47	14.24	14.59
Salt and Ash	3.41	3.19	1.93
Curd	.67	.79	.60
	100.	100.	100.

Butter made at the Station farm in a test of the Jersey cow, Alice, lasting from June 3 to June 16, 1897.

ANALYSES.

Number	3856	3861	3874	3879
Milkings	June 3-6	June 7-9	June 10-13	June 14-16
Fat	80.27	81.43	80.17	81.46
Water	15.20	14.63	15.20	13.90
Salt and Ash ..	3.57	3.04	3.70	3.95
Curd	.96	.90	.93	.69
	100.	100.	100.	100.

CANE JUICE—ACRE A.—PEDIGREED SEED.

Station No.	Date.	No. C. C. of Juice.	Specific Gravity.	Degrees Brix.	Reducing Sugar Per Cent.	Cane Sugar Per Cent.	Co-efficient of Purity.
4006	Oct. 5....	280.	1.087	20.9	2.38	17.62	84.3
4022	" 6....	270.	1.083	20.0	3.33	13.06	65.3
4025	" 6....	230.	1.080	19.3	3.79	12.20	63.2
4031	" 6....	325.	1.075	18.2	3.70	10.93	60.0
4042	" 7....	240.	1.085	20.4	3.29	13.96	68.4
4046	" 7....	245.	1.082	19.7	4.16	9.59	48.7
4047	" 7....	265.	1.084	20.2	3.84	13.56	67.1
4049	" 7....	235.	1.086	20.6	2.78	14.03	68.1
4066	" 8....	260.	1.098	23.25	1.54	17.45	75.1
4084	" 19....	195.	1.103	24.35	3.84	16.58	68.1
4088	" 19....	260.	1.096	22.8	9.09	10.19	44.7
4102	" 20....	200.	1.100	23.7	6.25	11.61	49.0
Average, exclusive of 4088 and 4102.		254.5	1.086	20.7	3.27	13.90	66.8

CANE JUICE—ACRE O.—MIXED SEED.

Station No.	Date.	No. C. C. of Juice.	Specific Gravity.	Degrees Brix.	Reducing Sugar Per Cent.	Cane Sugar Per Cent.	Co-efficient of Purity.
4013	Oct. 5....	230.	1.085	20.4	2.35	15.66	76.8
4018	" 5....	220.	1.093	22.2	1.23	17.43	78.5
4021	" 5....	310.	1.084	20.2	2.84	14.60	72.3
4032	" 6....	240.	1.094	22.4	1.68	17.20	76.8
4038	" 6....	225.	1.082	19.75	2.62	14.85	75.2
4060	" 7....	210.	1.083	19.95	3.13	14.15	70.9
4074	" 8....	345.	1.085	20.4	1.78	15.42	75.6
4075	" 8....	435.	1.086	20.6	2.08	15.35	74.5
4076	" 8....	380.	1.089	21.3	2.32	15.42	72.4
4080	" 8....	340.	1.086	20.6	1.85	15.09	73.3
4081	" 8....	305.	1.091	21.75	1.22	16.44	75.6
4096	" 19....	335.	1.086	20.6	3.33	14.32	69.5
4099	" 19....	330.	1.083	19.95	2.50	13.64	68.2
4114	" 20....	375.	1.084	20.2	2.38	14.74	73.0
4116	" 20....	380.	1.086	20.6	2.08	15.33	74.4
4117	" 20....	310.	1.092	21.95	1.35	16.89	76.9
Average....		310.6	1.0868	20.80	2.17	15.41	74.0

SUGAR BEETS.

Only two samples were analyzed in 1897, as follows:

3937.—Vilmorin's improved imperial, sent by Henry Waldron, Clay City, Ky., September 1st. The beets were raised by Mr. Waldron in his garden and are an average of those raised.

3959.—Another sample from Mr. Waldron.

ANALYSES OF THE JUICE.

Number	3937	3959
Specific gravity at 20° C.....	1.06	1.066
Brix	14.7	16.0
Per cent. sugar	10.66	10.4
Per cent. purity	72.5	65.

DRIED DISTILLERY FEEDS.

3968.—Corn feed, filter press, made by W. A. Gaines & Co., distillers, Frankfort, Ky.

3969.—Rye feed, filter press, made by same.

3970.—Rye feed, hydraulic press, same.

3971.—Corn gluten feed, same.

ANALYSES OF THE ROOM DRIED FEED.

Number	3968	3969	3970	3971
Moisture	7.02	6.62	6.76	6.57
Protein	26.19	18.13	17.19	26.56
Fat	8.85	7.23	9.48	9.63
Nitrogen-free extract	46.04	54.41	51.89	45.97
Fiber	10.12	11.77	12.37	8.89
Ash	1.78	1.84	2.31	2.38
	100.	100.	100.	100.

Nitrogen	4.19	2.90	2.75	4.25
Phosphoric acid	1.28	1.22	1.28	1.31
Potash	.20	.16	.29	.23

ANALYSES OF WATER-FREE FEED.

Number	3968	3969	3970	3971
Protein	28.17	19.42	18.44	28.43
Fat	9.52	7.74	10.17	10.31
Nitrogen-free extract	49.52	58.27	55.65	49.20
Fiber	10.88	12.60	13.26	9.51
Ash	1.91	1.97	2.48	2.55
	100.	100.	100.	100.

Nitrogen	4.51	3.11	2.95	4.55
Phosphoric acid	1.38	1.42	1.37	1.40
Potash	.22	.17	.31	.25

ARSENIC IN SPRAYED TOBACCO.

3666.—Tobacco raised at the Station farm in 1896, sprayed once with "new process Paris green" (See No. 3794).

3667.—Same, but sprayed two times.

3668.—Same, but sprayed three times.

3669.—Same, but sprayed four times.

3744.—Tobacco on which Paris green has been used. Sent by P. A. Cushman, Henderson, Ky.

ANALYSES OF THE ROOM DRIED TOBACCO.

Number	3666	3667	3668	3669	3744
Arsenious oxide, per cent.	.0022	.0081	.0030	.0031	.0005
“ “ grains in 1 lb	.15	.57	.21	.22	.03
Moisture, per cent.	6.64	6.51	6.75	6.61	—
Copper	Traces in each, not determined.				

INSECTICIDES AND FUNGICIDES.

3794.—Paris green, labeled on the box “New Process Paris Green, Lion Brand, manufactured by James A. Blanchard, New York.” The label also claims that this is “superior to any other Paris green yet offered” and that it “tends to prevent fungus or fungoid diseases.” The sample was taken from a lot that was used in the spraying experiments with tobacco at the Station farm in 1896 (See Nos. 3666–9). It is not as brilliant in color as genuine Paris green and not as finely powdered. The analysis shows it to be a mixture containing free arsenious acid and only a small proportion of Paris green, if any.

3795.—Paris green, labeled “Warranted strictly pure Paris green, Leggett & Bro., New York.” The sample was taken from a lot that was used in the spraying experiments with tobacco at the Station farm in 1895. It was a bright green color and the analysis shows it to be a good article of genuine Paris green.

3796.—Paris green from a 56 pound bucket obtained from Henry Heil & Co., St. Louis, in the spring of 1895 and used subsequently in various spraying experiments at the Station farm. The sample was bright green like 3795 and the analysis shows it to be a very good article of genuine Paris green.

3910.—Paris green bought in bulk of Chenoweth & Co., druggists, Maysville, Ky.; sent for analysis by Wm. Luttrell, Helena, Ky.

3911.—Paris green bought in one pound boxes of Chas. H. Fury, grocer, Helena, Ky.; sent for analysis by Wm. Luttrell, Helena, Ky., along with the preceding. The analyses show that both 3910 and 3911 are good Paris green.

ANALYSES.

Number.....	3794	3795	3796	3910	3911
	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.
Arsenious oxide.....	50.16	53.24	55.90	56.01	56.87
Cupric oxide	8.70	30.40	30.54	26.8	30.5
Sulphuric anhydride. 2.85					
Lime	19.48	trace	trace		
Water expelled at 126-130°C	8.35	1.00	1.25		
Carbon dioxide	trace	none	none		
Organic coloring mat- ter	present	none	none		
Acetic acid.....	not detected	15.36	12.31		
Combined water and undetermined.....	10.46				
	100.	100.	100.		

3871.—“Laurel green” from a sample barrel sent by the manufacturers, The Nichols Chemical Co., 32 Liberty street, New York. Their advertisements state that Laurel green is composed of lime, arsenic and copper sulphate compounded for use as an insecticide and fungicide and contains “from 5 to 10 per cent. of arsenic and about the same of copper.” The material was a dull blue-green colored powder which dissolved in hydrochloric acid with effervescence, leaving only a very slight residue. The following analysis seems to indicate that the material contains a considerable amount of land plaster in addition to the constituents enumerated.

ANALYSIS.

Arsenious Oxide	3.17 per cent.
Copper Oxide.....	11.55 “ “
Lime.....	28.29 “ “
Magnesia	3.10 “ “
Peroxide of Iron.....	2.26 “ “
Sulphuric Anhydride	28.87 “ “
Residue insoluble in hydrochloric acid	.65 “ “
Water, carbon dioxide and loss.....	22.11 “ “
	100.
Loss by ignition to low redness.....	20.02 “ “

NITRE EARTH.

3994.—Nitre earth sent by C. W. Quiggins, Elizabethtown, Ky. It is a brownish, clayey material containing much fine sand and banded in appearance on the cross section as if it had been deposited in thin layers from water. It has been used successfully as a fertilizer for tobacco. The sample was moist when received and lost 7.24 per cent. on air-drying.

ANALYSIS.

	As rec'd. per ct.	Air-dried per ct.
Nitrogen	0.35	0.38
Lime	5.10	5.50
Equivalent in carbonate of lime	9.09	9.80
Potash soluble in hydrochloric acid 1.115 sp. gr. .	.47	.51
Potash soluble in 1-5 normal nitric acid	.08	.09
Potash soluble in 10 per cent. acetic acid	.07	.08
Phosphoric acid	.14	.15
Silica and silicates insoluble in hydrochloric acid, 1.115 sp. gr. }	67.13	72.37

HOG MANURE.

3972.—Manure sent by Dr. P. W. Foote, Irvington, Ky. The skim and buttermilk from the dairy are fed to pigs along with corn and shipstuff. The manure is collected and dried, ground and drilled with wheat at the rate of about 300 to 400 pounds per acre.

ANALYSIS.

Total phosphoric acid	1.28 per cent.
Nitrogen	.58 " "
Equivalent to ammonia	.70 " "
Potash	.33 " "

MARLS.

3995.—Nearly white, clay-like material from the upper eight inches of the bed; sent by Judge John S. Adair, Hawesville, Ky., December 16, 1897. This was found to effervesce strongly with acids.

3996.—Chocolate-brown material from the middle 16 inches of the same bed; sent with the above. This was mostly soft, but contained some harder light brown pieces resembling weathered chert, but which effervesced strongly with acids and contained manganese.

3997.—Greenish shaly material from the lower three feet of the same bed; sent with the above. This resembles the so-called green "Leitchfield marl." Weathered surfaces show a brown, ferruginous stain. These samples were all taken from the outcrop.

ANALYSES.

Number	3995	3996	3997
Lime, per cent	12.02	8.79	0.88
Equivalent in carbonate of lime	21.46	15.52	1.58
Phosphoric acid	.50	.16	.20
Potash soluble in hydrochloric acid 1.115			
sp. gr	.63	.61	1.48
Potash soluble in 10 per cent. acetic acid	.03	.03	.05
Potash soluble in 1-5 normal nitric acid	.01	.03	.03
Silica and silicates insoluble in hydrochloric acid 1.115 sp. gr	60.47	50.54	76.86

WOOD ASHES.

3991.—Ashes from hardwood, mostly oak; sent by J. J. Payne, Warsaw, Ky.

ANALYSIS.

Potash	0.62 per cent
Phosphoric acid	0.60 "
Lime	36.44 "

PHOSPHATIC ROCKS FROM FAYETTE COUNTY.

3646.—Black soft substance containing much iron gravel and some soft white particles, taken at a depth of about two feet in a deposit of soft material probably derived from the weathering down of the phosphatic layers of the upper part of the Trenton limestone and beneath, and more or less mixed with soil. Locality about two miles from Lexington on the L. & E. R. R. Collected December 23, 1896, by Scovell.

3647.—Iron gravel from the same locality; collected by Scovell.

3648.—Soil and clay or soft phosphate from the same locality; collected by Scovell.

3649.—Soil, gravel, &c., from the surface of the deposit; same locality; collected by Scovell and Peter.

3650.—Selected soft phosphate from same locality, taken about 1½-2 feet deep; collected by Curtis and Peter.

3651.—Average sample from a layer of the same material as 3650 about one foot thick; collected by Peter and Curtis.

3766.—Phosphatic breccia on the old Frankfort pike, near the branching off of the Yarnallton extension. Found on the surface of the ground in large lumps resembling chert. It is composed of iron gravel, fragments of chert and a brownish material which is probably phosphate of lime, the whole being so iron stained that it was difficult to decide whether the light colored material or the iron and manganese oxides formed the cement. On treating the material with hydrochloric acid there was evolution of chlorine gas with little or no carbon dioxide and quite a large residue was left undissolved.

ANALYSES.

Number	3646	3647	3648	3649	3650	3651	3766
Phosphoric acid							
per cent	7.65	4.50	17.83	10.67	27.97	24.10	4.81
Equiv. in phosphate of lime	16.71	9.83	38.95	23.30	61.08	52.64	10.51

POTASH SALTS AND MISCELLANEOUS FERTILIZERS.

3893.—Kainit from stock at the Station farm.

3914.—Sulphate of potash; sent by Henry S. Berry, Owensboro, Ky., who bought it of the Cleveland Dryer Co., Cleveland, Ohio, in 1896. Guaranteed 95 per cent. The salt is white and contains only traces of chlorides.

3915.—Sulphate of potash sent with the preceeding; bought by Mr. Berry, of the Mapes Formula and Peruvian Guano Co. in 1897. The salt is brown, but contains only traces of chlorides.

ANALYSES.

Number	3893	3914	3915
Potash, per cent	13.30	49.8	49.5
Equivalent to sulphate of potash	—	92.6	91.9

3889.—By product from the manufacture of tobacco extract; sent by Fried. Gloystein, Henderson, Ky. A brown, finely granular powder having a strong smell of tobacco. Qualitative tests showed that it contained a large proportion of sulphate of lime.

ANALYSIS.

Nitrogen	2.11 per cent
Potash	19.94 "
Phosphoric acid	a trace

3715.—Banner dissolved bone, manufactured by the Michigan Carbon Works, Detroit, Mich. Sample from a lot that was used in field experiments at the Station farm in 1896.

ANALYSIS.

Number	3715.
Available phosphoric acid	28.05 per cent.
Insoluble " "	6.12 " "
Total " "	34.17 " "
Equivalent to 75.54 per cent. bone phosphate.	
Nitrogen	0.32 " "
Equivalent to 0.39 per cent. ammonia.	

3820.—Damaraland guano, imported by H. J. Baker & Bro., New York, from the west coast of Africa.

Sample from a 200-pound bag presented by the importers. It is a brown material containing many hard lumps of saline matter, some of them 2 or 3 inches thick. The label on the sack states that it is a natural bird guano, sold in its pure natural state.

ANALYSIS.

Number	3820.		
Soluble phosphoric acid	6.69	per cent.	
Reverted " "	5.68	" "	
Insoluble " "	2.65	" "	
Total	15.02	" "	
Nitrogen	6.84	" "	
Equivalent to ammonia	8.36	" "	
Potash (from muriate)	3.71	" "	

MINERAL WATERS.

3906.—Chalybeate water sent for analysis by Mrs. Margaret H. Clarke, Owensboro, Ky., from a well on her place

ANALYSIS.

Carbonate of Iron	1.28 grains per gallon
" " Lime	} considerable.
" " Magnesia	
" " Soda	traces.
Sulphates and chlorides of Sodium and potassium	} traces.
Organic matters	
Total solid matters	22.8 grains per gallon

✓ 3907.—Mineral water brought by J. R. Phillips, McBrayer Ky.

The analysis shows this to be a very good chalybeate water all the iron being in the form carbonate.

ANALYSIS.

Carbonate of iron	a trace
" " lime	} moderate quantity.
" " magnesia	
" " soda	
Chloride of sodium	considerable quantity
Sulphate of soda	} moderate quantity.
" " potash	
Borates, iodides, lithium salts and organic matter	} traces.
Total solid matters	
	32.8 grains per gallon

✓ 3918.—Mineral water brought by R. R. Early, Versailles, Ky. The jug was stopped with a corn cob and the water contained some chaff from this source. There was a slight smell of petroleum.

ANALYSIS

Carbonate of iron	trace.
“ lime	} considerable quantity.
“ magnesia	
Sulphates and chlorides of potash and soda	small quantity.
Lithium and strontium compounds	traces.
Nitrates and organic matters	considerable.
Total solid matters	16.7 grains per gallon.

3947.—Chalybeate water sent by J. M. Campbell, Adairville, Ky.; from his farm.

ANALYSIS.

Carbonate of iron	2.68 grains per gallon.
“ “ manganese	small quantity.
Carbonates of lime and magnesia	moderate quantity.
“ “ soda and potash	small quantity.
“ “ lithia and strontia	traces.
Sulphates and chlorides of sodium or potassium	traces.
Silica	small quantity.
Total solid matters	15.8 grains per gallon.

This is a good chalybeate water containing a notable amount of manganese.

3974.—Mineral water from well of D. H. James, 125 feet deep.

ANALYSIS.

Carbonates of iron, lime and magnesia	small quantities.
Chloride of Sodium	much.
Chlorides of calcium and magnesium	moderate quantities.
Chlorides of potassium and lithium	marked traces.
Iodide of sodium	“ “
Bromide of sodium	very marked.

Sulphate of lime	small quantity.
Sulphate of strontium	traces.
Biborate of soda	"
Sulphide of sodium	small quantity.
Total solid matters	781 grains per gallon

3907.—Mineral water from a well near Cynthiana, Ky collected by M. A. Scovell.

3924.—Sulphur water from a spring on the Q. & C. R. near Green River bridge, sent by Supt. W. J. Murphy.

3981.—Mineral water from the bored well of W. R. Renfro Lexington, Ky. The well is 66 feet deep and is situated on the Nicholasville pike just south of the city.

ANALYSES in grains per gallon.

	3907	3924	3981
Carbonate of iron	.18	.15	1.010
Carbonate of lime	10.55	9.74	3.749
Carbonate of magnesia	3.67	—	3.842
Carbonate of strontia	—	—	.117
Carbonate of lithia	traces	.87	.058
Carbonate of soda	5.19	—	7.398
Chloride of sodium	61.68	42.07	8.290
Chloride of potassium	—	—	.898
Bromide of sodium	—	.08	—
Bromide of potassium	notable quantity	—	.020
Sulphate of soda	—	—	1.698
Sulphate of potash	2.51	1.61	—
Sulphate of magnesia	4.60	15.48	—
Sulphate of lime	—	26.33	—
Sulphate of baryta	—	—	.071
Sulphide of sodium	notable quantity	10.60	trace
Iodides	—	traces	trace
Borates	—	traces	trace
Nitrates and organic matters	traces	traces	traces
Silica	.47	.87	.455
Total solid matters	88.85	107.80	27.651

Free sulphuretted hydrogen gas..	—	4.61	.205
Free ammonia, parts in 1,000,000..	—	—	0.57
Albuminoid ammonia, “ “ ..	—	—	.04

WINE.

3819.—Concord wine, made by Thos. R. Walker, Junction City, Ky. The wine has a very rich red color and fine bouquet; the flavor also is excellent, though somewhat too acid and astringent. Its specific gravity was 1.0065 at 15.5° C.

ANALYSIS.

Number	3819.
Alcohol	10.47 per ct. by wt.
Reducing sugars	3.60 [=13.25 by vol.]
Total residue on evaporation	5.54
Ash	.14
Total acid, calculated as tartaric	.81
Fixed “ “ “ “	.71
Volatile acid “ “ acetic	.077

COALS.

3645 —Elkhorn coal sent by Maj. H. C. McDowell, January 5, 1897, from a mine on the L. & E. R. R. at Jackson. Average sample.

3767.—Average sample of a “parting” about one inch thick in the Elkhorn coal No. 3645. Brought by Dr. W. O. Sweeney, April 6, 1897.

3853.—Elkhorn coal, same as 3645; hand specimen brought Chas. Hendrie.

3999.—Cannel coal; J. Waller Rodes, Lexington, Ky.

ANALYSES.

Number	3645	3767	3853	3999
Moisture	2.78			
Volatile combustible matters.	35.65		44.25	61.47
Fixed carbon	57.64		53.83	28.90
Ash	3.93	6.10	1.92	9.63
	100.00		100.00	100.00

Sulphur	0.97		
Coke	61.57	55.75	38.53
Color of the ash	nearly white	white	buff.

COKES.

3828.—72 hour coke made from crushed Elkhorn coal (No. 3645) and representing the whole bed; brought by Dr. W. O. Sweeney and Mr. Chas. Hendrie. A very good looking, compact, very fine grained coke.

3849.—Coke made from the top bench of the Elkhorn coal No. 3645.

3850.—Coke made from the lower bench.

ANALYSES.

Number	3828	3849	3850
Moisture and volatile matter	0.93	1.57	1.35
Fixed carbon	92.93	92.18	93.15
Ash	6.14	6.25	5.50
	100.00	100.00	100.00
Sulphur	0.75	0.62	0.78
Phosphorus	0.017		
Color of the ash	red.		

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Division of Entomology and Botany.

M. A. SCOVELL, *Director*.

Sir.—I submit herewith a report of the Entomological and Botanical Division for the year 1897 :

During the summer of 1897 the time of the Entomologist and Botanist was given for over a month to the inspection of Kentucky nurseries, a law having been enacted at the special session of the General Assembly making this work a part of his duties and constituting him State Entomologist. Contrary to my expectations, the San Jose Scale was not discovered in any of our nurseries, and Kentucky fruit growers have little to fear from them as sources of infection. It is possible, of course, that the scale may be brought to such nurseries in the future, yet, with the certificates of inspection required by the law with every package of imported nursery stock, the danger is greatly lessened. The chief danger now to be feared is from centers that became infected before the law was enacted. So far as I know, the scale has only been introduced into the State by individuals who have obtained stock direct from outside dealers, and the fact calls attention to the need of a clause in the law making it obligatory upon *anybody* to destroy the scale when it is found upon his premises. A draft of a bill requiring the destruction of the scale wherever found was prepared toward the close of the last regular session of the General Assembly, and will be presented at the next session.

Some attention was given to the weed known as Woolly Mullein (*Verbascum phlomoides*) that has been introduced into several counties southwest of Louisville along Nolin River. From my observations made last season on cultivated land that had been in 1896 infested I was impressed with the fact that it is not calculated to give trouble in cultivated fields. In a corn field where the mullein was abundant in 1896 I could not find a single plant.

Experiments have been made during the summer on tobacco insects, on broom-rape, on the gape worm, potato scab, apple rot, and observations have been continued on forage plants with reference to a future bulletin.

Bulletin 67, published in May, 1897, contains an account of the San Jose Scale, with remedies for its injuries.

Bulletin 69 of the Station series contains a couple of articles from my Division, on varieties of wheat and on the treatment of seed wheat.

Bulletin 70, contains an account, with illustrations, of the Woolly Mullein, and an illustrated article on the gape disease of poultry.

Bulletin 72 contains two articles giving the results of experiments in preventing scabbing of potatoes.

Considerable attention has been given during the winter to perfecting our equipment, in apparatus and literature, for work in bacteriology, a subject that is rapidly looming up in importance in agriculture and medicine. Some attention has been given to growing several aroma-producing bacteria and introducing them into butter as a means of improving its flavor. One of those tested seems to have a value for this purpose, and gives a butter that is generally pronounced by unbiased judges superior to the best butter made without the aid of the culture. Mr. Harper, Dairyman of the Station, has devoted a good deal of time in my Division to special work in bacteriology, along a somewhat different line, as a preparation for a post graduate degree, and has obtained some interesting results.

The instruction in Entomology in the College has always been in my hands since its introduction as a part of college work here. In 1895-96 Miss Didlake prepared her post graduate thesis in my Division. During the winter of 1897-98 the number of students, including the specials in Agriculture and a senior engaged in thesis work, required considerable time from Station work. This teaching is not properly a part of Station duty, and has been accepted solely as an accommodation to those who are trying to build up the agricultural side of the College. If I am to give time to it in the future I wish to suggest that this instruction should be formally recognized as a part of Station work, that my Division may have proper credit for what it is doing in this line.

Assistance in the Vivarium, now in excellent condition, has been given me during part of each school day and on the whole

of Saturdays by Mr. G. N. Keller, an undergraduate in the Agricultural course.

Miss Mary L. Didlake, of Lexington, an alumnus of the College has rendered very useful service to my Division in arranging and labeling the herbarium collection.

Respectfully submitted,

(Signed) H. GARMAN,
Entomologist and Botanist.

Division of Horticulture.

M. A. SCOVELL, *Director*.

SIR:—I submit herewith a report of the Horticultural Division for the year 1897.

As noted in my report of one year ago, the horticultural work of the Station has been receiving of late a comparatively small portion of my time, on account of the increasing amount of college duties.

The work has therefore been confined mainly to experiments with small fruits, particularly, strawberries and grapes, which require a maximum amount of attention during the summer vacation. The past season has been on the whole quite favorable to these crops, as the droughts of the late summer did not commence early enough to do serious injury to the small fruits.

Of the strawberries, we had in culture III varieties, of which a considerable number were in fruit for the first time with us.

During the fall we have sent out inquiries relating to the strawberry crop, the methods of its cultivation, the value of different varieties, etc., all over the State, in order to secure information from various sources to combine with our own data upon this subject.

The results of our own experiments together with this information received from other growers, are now being brought

together and will soon be ready for publication, as a bulletin of the Station.

Our young experiment vineyard has been increased during the year by the addition of a considerable number of new varieties, and the older vines have given for the first time nearly a full crop of fruit.

This first crop of fruit of about sixty varieties has been of great interest to us, and has attracted a good deal of attention from visitors.

Among the varieties are several which seem to give promise of becoming valuable additions for special purposes to the kinds heretofore grown in Kentucky.

A number of minor experiments have been conducted with vegetables in the field, and the forcing houses have been utilized as heretofore, for winter vegetables, especially lettuce, and for the propagation of plants for outdoor setting in the spring.

Respectfully submitted,

(Signed) C. W. MATHEWS,
Horticulturist.

Division of Meteorology.

M. A. SCOVELL, *Director*,

Dear Sir:—I submit herewith a brief meteorological summary for the year 1897.

Very respectfully, V. E. MUNCY, *Observer*.

Annual Meteorological Summary for 1897.—Station, Lexington, Ky.

TEMPERATURE.

FROM SELF-REGISTERING INSTRUMENTS.

No. of Days.

MONTHS

MEAN.

Max.

Min.

Month-ly.

High-est.

Date.

Lowest.

Date.

RANGE.

Absol-ute.

Mean daily.

Mean daily change.

Max. below 32°.

Max. above 90°.

Min. below 32°.

Jan ...	37.6	22.3	30.0	67	3	-6	25	73	15.3	7.0	8	0	23
Feb ...	44.6	30.2	37.4	66	17	10	27	56	14.4	5.8	1	0	17
Mar ...	56.4	38.7	47.6	76	22	22	27	54	17.7	7.3	0	0	8
Apr ...	62.0	44.4	53.2	82	28	26	20	56	17.7	6.1	0	0	2
May ..	68.5	50.3	59.4	87	8	33	2	54	18.2	5.6	0	0	0
June ..	82.0	62.1	72.1	93	15	50	9	43	19.9	4.1	0	4	0
July...	84.9	66.5	75.7	95	4	54	13	41	18.5	2.8	0	8	0
Aug ...	83.9	63.6	73.8	96	3	55	17	41	20.3	3.1	0	5	0
Sept ..	85.2	60.0	72.4	96	14	40	21	56	25.5	4.1	0	11	0
Oct ..	75.7	52.1	63.9	88	15	36	30	52	23.6	3.0	0	0	0
Nov ...	55.8	37.0	46.4	71	15	17	30	54	18.8	6.9	0	0	7
Dec ...	43.5	30.1	36.8	67	9	8	24	58	13.5	7.2	4	0	18
Sum ..	780.1	557.3	668.7	a. Max.	a. Date.	a. Min.	Date.	638	223.4	63.0	13	28	75
Mean	65.0	46.4	55.7	96	14	-6	Date.	53	18.6	5.2	a.	a.	a.

BAROMETRIC PRESSURE.

(Corrected for temperature and instrumental error only).

Elevation of Barometer Cistern Above Mean Sea-Level, on Dec. 31, 1909 Feet.

(All barometer readings have been reduced to above elevation).

MONTHS.	Monthly.	Highest Observed.	Date.	Lowest Observed.	Date.	Absolute range.
		In.		In.		In.
January	29.07	29.46	30	28.66	17	.79
February	28.97	29.55	27	28.50	6	1.04
March	28.98	29.39	15	28.39	19	1.00
April.....	29.01	29.54	20	28.61	9	.92
May	28.98	29.32	18	28.67	2	.65
June	28.95	29.08	10	28.79	17	.29
July.....	28.94	29.16	19	28.75	11	.41
August	28.97	29.14	5	28.74	10	.40
September.....	29.11	29.29	21	28.91	19	.38
October	29.04	29.35	14	28.61	11	.74
November	29.06	29.50	17	28.54	1	.96
December	29.02	29.39	24	28.54	13	.85
Sum.	348.10	^a Highest.	^a Date. Feb.	^a Lowest.	^a Date. Mar.	8.43
Mean	29.01	29.55	27	28.39	19	.70

KENTUCKY AGRICULTURAL EXPERIMENT STATION, xxxvii

PRECIPITATION.

(Amount in inches and hundredths.)

Elevation of top of gauge above ground, December 31, 2 feet.

MONTHS.	Total Amount.....	Greatest Amount in any 24 Consecutive Hours.		No. of days on which 1 inch fell	No. of days on which no rain except "Trace" fell	No. of Consecutive Days Without Rain.
		Amt.	Date.			
	Inches.	Inches.				
Jan	2.59	.91	{ 3 4	0	19	from 9 to 12 inc.
Feb	6.33	1.32	{ 20 21	3	14	from 13 to 17
Mar	6.55	1.29	{ 8 9	2	13	from 25 to 29
Apr	5.80	1.22	8	2	14	from 18 to 22 from 5 to 8 from 16 to 20
May	4.48	1.28	{ 11 12	0	18	from 24 to 27 from 30 to 2
June	4.77	2.32	{ 23 24	2	18	from 9 to 15 from 25 to 29
July	4.34	2.29	{ 15 16	1	17	from 7 to 9 from 13 to 15 from 27 to 30
Aug.....	3.21	.89	22	0	23	from 5 to 9 from 11 to 14 from 16 to 21 from 26 to 28
Sept	.80	.42	2	0	27	from 3 to 15 from 18 to 10
Oct	.38	.17	11	0	25	from 10 to 19 from 21 to 27 from 12 to 15
Nov.....	4.83	1.54	{ 31 1	1	18	from 17 to 21 from 27 to 2
Dec	5.11	1.34	20	1	17	from 6 to 10 from 27 to 30
Sum.	49.19	a.	a	a.	a.	
Mean	a.	a.	a.	a.	a.	

Normal rainfall for April 3.72 inches.

Normal rainfall for May 3.49 inches.

Normal rainfall for June 4.25 inches.

Normal rainfall for July 5.18 inches.

Normal rainfall for August 3.52 inches.

Normal rainfall for September 2.54 inches.

SUNSHINE AND CLOUDINESS.

MONTHS.	NUMBER OF DAYS.			MEAN CLOUDINESS. (0 to 10).		
	Clear.....	Partly cloudy..	Cloudy	8 a. m.	8 p. m.	Monthly
January	7	7	17	6.8	5.2	6.9
February	6	4	18	8.0	7.2	7.4
March	3	13	15	7.3	6.4	7.3
April	7	9	14	7.2	5.6	6.3
May	13	7	11	5.0	5.5	5.3
June	7	16	7	6.4	5.9	5.9
July.....	7	14	10	5.9	6.0	6.0
August	10	18	3	3.9	4.5	4.6
September.....	25	4	1	1.5	1.2	1.8
October	23	3	5	2.7	2.0	2.4
November	10	6	14	5.6	5.5	6.1
December ..	3	6	22	8.7	8.3	8.0
Summary	121	107	137	69.0	63.3	68.0
Mean	<i>a</i>	<i>a</i>	<i>a</i>	5.8	5.3	5.7

WIND.

Elevation of anemometer cups above ground December 31, 104 feet.

MONTHS.	Prevailing Direction.	Maximum Hourly Velocity During Month.			No. of Days With Gales.	No. of Calms.
		Miles.	From.	Date.		
January	N. W.	48	N. W.	18	4	0
February	N. E.	42	N. W.	15	1	0
March	S. W.	50	S. W.	5	4	0
April	S. W.	44	S. W.	13	1	0
May	N. W.	38	S.	23	0	0
June	S. W.	48	S. W.	18	1	3
July	S. W.	40	S.	24	1	2
August	S. W.	46	N. E.	22	2	0
September	E.	24	S. W.	25	0	0
October	S. W.	30	S. W.	11	0	0
November	S.	50	W.	9	1	0
December	S. W.	40	S. W.	5	1	0
Summary	<i>a.</i>	<i>a.</i>	<i>a.</i>	<i>a.</i>	16	5
Mean	S. W.	<i>a.</i>	<i>a.</i>	<i>a.</i>	<i>a.</i>	<i>a.</i>

NUMBER OF DAYS.

MONTHS.	Thunder- storms.	Snow.	Hail.	Fogs.
January	0	7	0	1
February	4	2	1	0
March	2	0	0	0
April.....	1	0	0	1
May	2	0	0	0
June	5	0	0	0
July.....	8	0	0	0
August	4	0	0	0
September	1	0	0	0
October	0	0	0	0
November	1	0	0	0
December	1	5	0	0
Summary	29	14	1	2
Mean	<i>a.</i>	<i>a.</i>	<i>a.</i>	<i>a.</i>

KENTUCKY
AGRICULTURAL EXPERIMENT STATION

OF THE

STATE COLLEGE OF KENTUCKY.

BULLETIN NO. 66.

TOBACCO.

LEXINGTON, KENTUCKY,
FEBRUARY, 1897.

Fogs.

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KENTUCKY AGRICULTURAL EXPERIMENT STATION,
LEXINGTON, KY.

BULLETIN NO. 66.

TOBACCO.

Test of Fertilizers.

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 $11\frac{1}{2}$ 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.....	240	530	260	265	240	1295
	Nitrate of Potash ...	200					
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, ranging 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
.....	.....	.....	.....	.....	3
None alive .....	.....	.....	.....	.....	4
2 alive.. .....	.....	.....	.....	.....	5
2 alive..	None alive .....	.....	.....	.....	6
3 alive..	3 alive .....	.....	.....	.....	7
3 alive..	3 alive	None alive .....	.....	.....	8
2 alive..	2 alive..	2 alive.. .....	.....	.....	9
2 alive..	None alive .....	.....	.....	.....	10
3 alive..	2 alive.. .....	.....	.....	.....	11
2 alive, 1 miss'g ..	1 alive..	None alive .....	.....	.....	12
3 alive..	3 alive..	3 alive.....	.....	.....	13
.....	.....	.....	.....	.....	14
.....	.....	.....	.....	.....	15
.....	3 alive... ..	2 alive	1 alive, a pupa .....	.....	16
.....	1 alive	1 alive	1 alive, a pupa .....	.....	17
1 alive..	None alive .....	.....	.....	.....	18
3 alive	3 alive .....	.....	.....	.....	19
.....	None alive .....	.....	.....	.....	20
.....	2 alive ....	.....	.....	.....	21
.....	.....	.....	.....	.....	22
.....	.....	.....	.....	.....	23
.....	2 alive	2 alive	None alive .....	.....	24
.....	1 alive	1 alive	None alive .....	.....	25
.....	None alive .....	.....	.....	.....	26
.....	3 alive ....	.....	.....	.....	27
.....	1 alive	1 alive	1 alive . . .	None alive	28
.....	2 alive	2 alive .	2 alive .	1 alive...	

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

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None

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None

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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, Louisiana, 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 broomrape (*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.

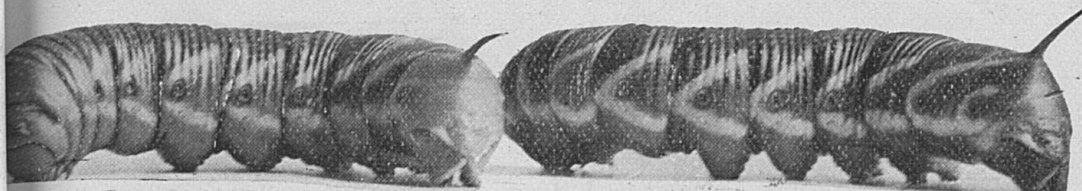
EXPLANATION OF THE FIGURES.

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.

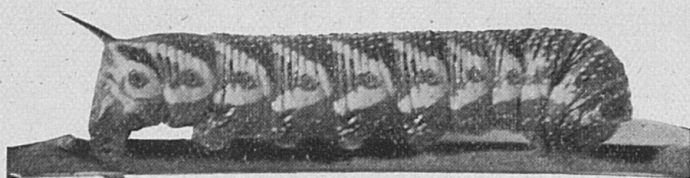
Figure 3.—The moth of the southern worm. Natural size. Photographed by H. Garman.

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

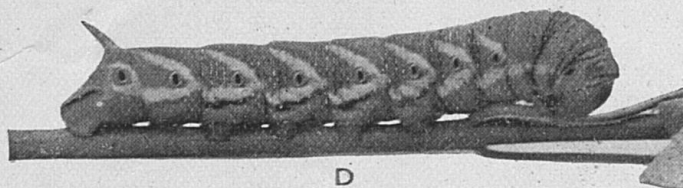


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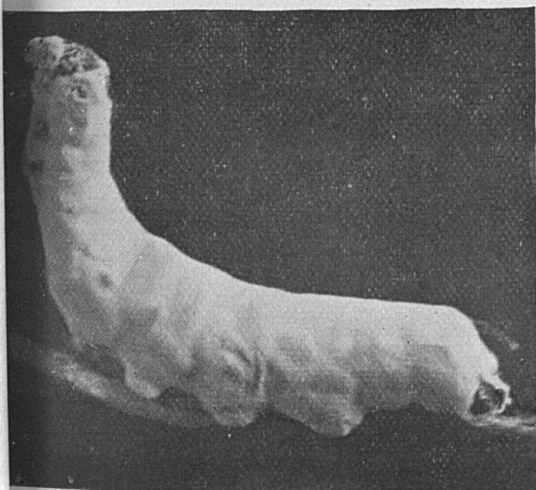
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C



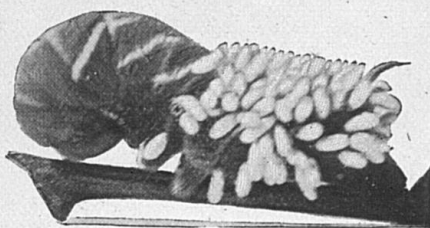
D



G



E



F

FIG. 1.

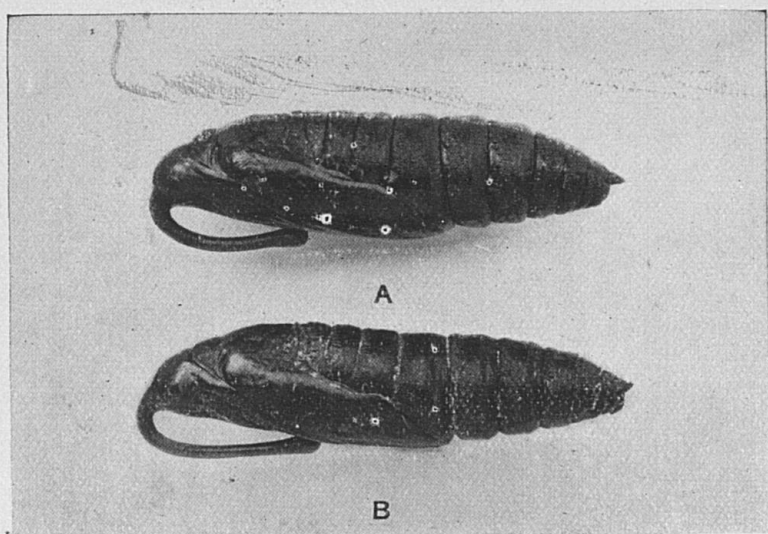


FIG. 2.

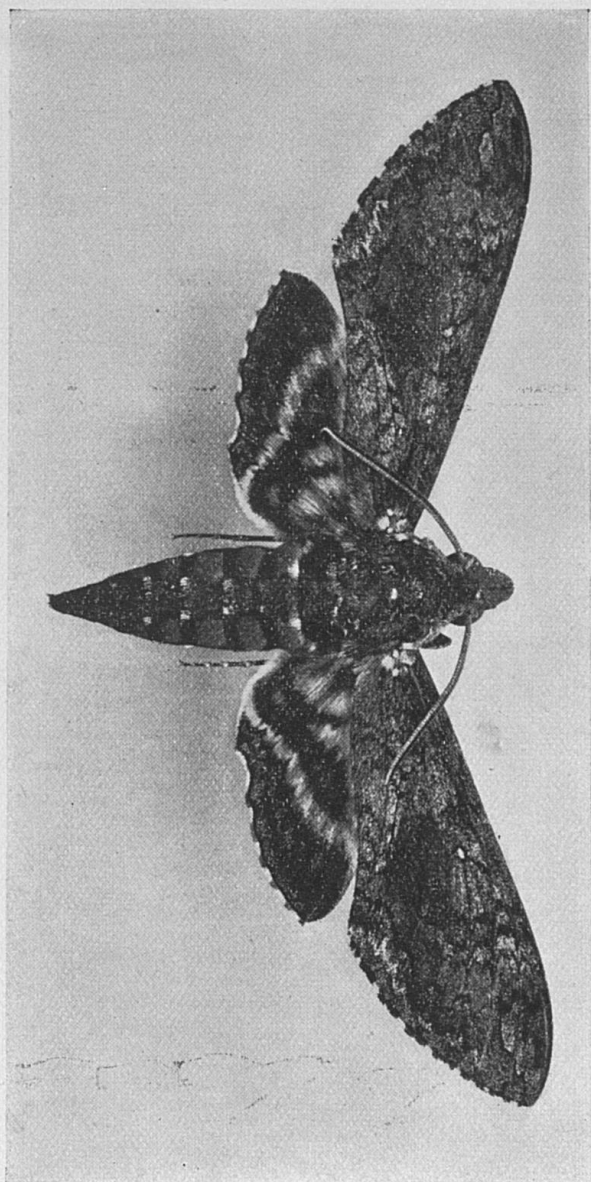


FIG. 3.

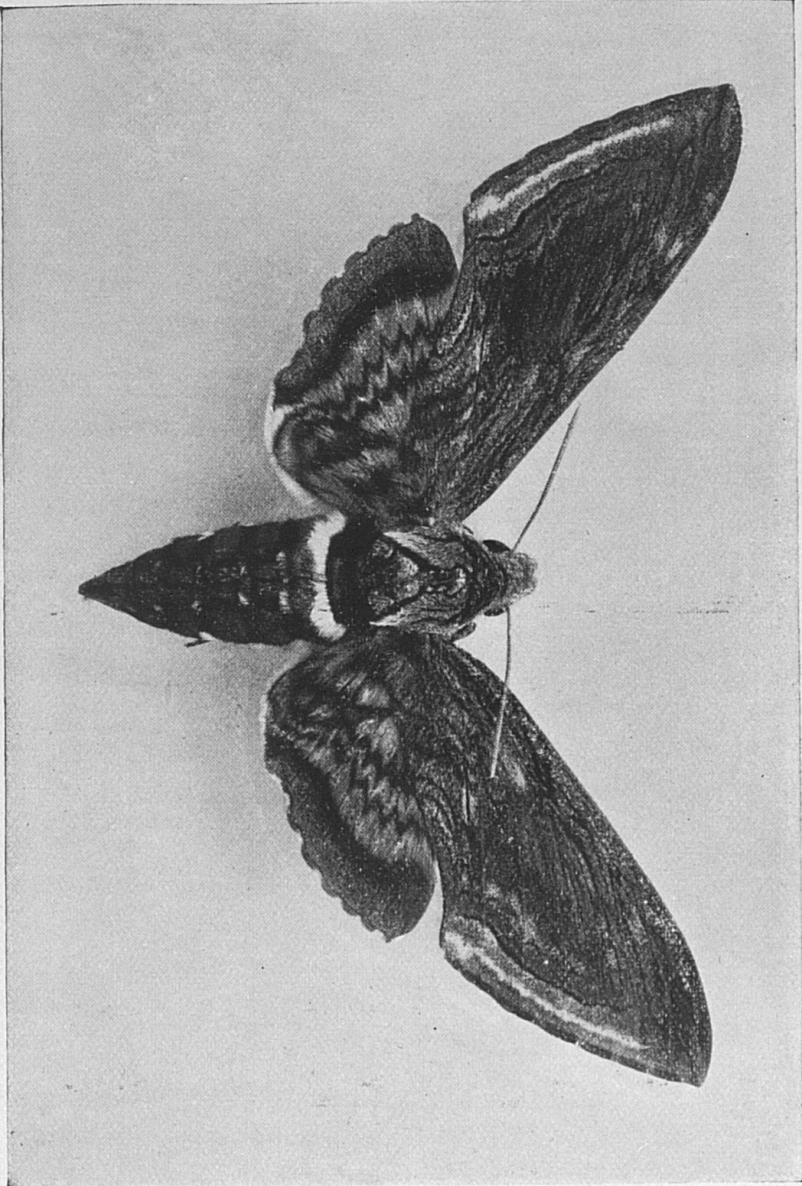


FIG. 4.

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

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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 *Fapyx 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.

KENTUCKY
AGRICULTURAL EXPERIMENT STATION

OF THE

STATE COLLEGE OF KENTUCKY.

BULLETIN No. 67.

THE SAN JOSE SCALE IN KENTUCKY.

LEXINGTON, KENTUCKY,

May, 1897.

KENTUCKY

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LEXINGTON, KY.

*Deceased.

tion.

BULLETIN No. 67.

THE SAN JOSE SCALE IN KENTUCKY.

BY H. GARMAN, ENTOMOLOGIST AND BOTANIST.

ents.

In the recent history of horticulture in this country no other insect has excited so much apprehension among fruit growers and nurserymen. Its notoriety is well deserved for its pernicious character has been demonstrated over and over again wherever it has obtained a foothold. The death of trees which become infested with it seems to be only a question of a few years. The secret of its destructiveness lies in its small size and unfamiliar shape and habit, coupled with its extraordinary powers of multiplication. Because of these characteristics it is often introduced on trees into orchards and nurseries, where its presence is not detected until its deadly effect on infested plants draws attention to it; and even then so little does it resemble ordinary destructive insects with which every fruit grower is familiar that its nature as a living animal is not readily perceived. Writing of the pest in 1896 Messrs. Howard and Marlatt, of the United States Department of Agriculture, say: "The Los Angeles Horticultural Commission reported in 1890 that if this pest be not speedily destroyed it will entirely ruin the deciduous fruit interests of the Pacific coast. Its capacity has been more than demonstrated since its appearance in the East, and it has been, if anything, more disastrous to the

peach and pear orchards of Maryland, New Jersey, and other Eastern and Southern States than in California and the West."

"We are therefore justified in the assertion that no more serious menace to the deciduous fruit interests of this country has ever been known. There is no intention here to arouse unnecessary alarm, but mainly to emphasize the importance of taking the utmost precautions to prevent its introduction into new localities, and to point out the extreme necessity of earnest effort to stamp it out where it has already gained a foothold."

ITS NAME AND ORIGIN.

Insects of this sort are called scale insects because the body is covered and concealed by a buckler shaped plate, consisting partly of moulted skins and in part of a secretion. The edges of this scale cover are closely applied to the bark or leaf so that no trace of legs or other organs is visible. But when the scale is removed the insect to which it belongs will be found beneath with its long proboscis inserted in the plant upon which it rests. Even when thus uncovered it is necessary to use a compound microscope to show clearly its general resemblance in structure to ordinary insects. When such insects become abundant on trees the scales are so thickly placed that they overlap each other and conceal the bark, forming a continuous layer with a slightly glistening appearance.

The scale insect with which we are here dealing became known to American fruit growers as the San Jose scale because it was first observed in this country on fruit trees in the San Jose Valley of California. It has been asserted that it was brought to California from Chili, but the evidence is not conclusive, and since it occurs in other parts of the world from which trees have been brought to California, it is still uncertain where it did come from.

ITS HISTORY IN THE UNITED STATES.

Since its appearance in the San Jose Valley, about 1870, the scale has spread over most of the fruit growing sections of the West, and about four years ago was discovered in Virginia, to which State it was brought on fruit trees obtained at New Jersey nurseries. The latter are believed to have received the scale on plum trees obtained from California in 1886, and had thus in all probability been sending out infested stock for several years before the fact became known. From these nurseries it now appears that most of the Eastern States have received more or less infested stock, but the centers of greatest abundance for the scale appear to be New Jersey, where San Jose scale probably occurs in every county, Eastern New York, Maryland, and Ohio.

It is so insidious, however, in its spread and injuries that it is likely to be encountered at any time in any Eastern State, and Kentucky fruit growers must not hope to escape its injuries without exercise of the greatest care and watchfulness. It has been for some time on our borders just across the Ohio River in Ohio, Indiana and Illinois. It is known to me to have been brought in at least one instance to Kentucky, and I would advise every fruit grower and nurseryman in the State to examine any trees recently obtained from infested localities, and if any are found which appear to be infested to report the fact to this Station.

ITS FOOD PLANTS.

San Jose scale attacks most, or all of the deciduous fruit trees and shrubs. It spreads from them at times to other plants, such as linden, elm, osage orange, etc., but is preeminently a fruit pest, and as such has no equal at present in this country.

THE NATURE OF ITS INJURY.

Insects might be arranged in two groups, according to their manner of attacking plants. Such as the army worm, tobacco worm and potato beetle gnaw away and devour the substance of plants, and can generally be destroyed by putting poisons like Paris green on the plants they attack. But a more troublesome group is composed of insects that are provided with piercing beaks by means of which they suck up the sap of plants. Because of their manner of feeding they cannot be readily killed unless some preparation with corrosive or other destructive properties can be brought in contact with their bodies.

The San Jose scale is one of these puncturing insects, and if one of the scales is removed and the insect beneath is carefully detached from the bark, the slender beak, consisting of several very fine threads, will by the procedure be withdrawn from the bark and may be seen under the microscope arising from the mouth near the front end of the body.

Now a single scale insect such as this, or even a hundred, would do no serious harm to a thrifty tree, but the San Jose scale increases at so rapid a rate that the bark of infested trees soon becomes thickly covered, and the insects may spread thence to leaves and fruit. It has been stated that the offspring of a single female during one season would if all the eggs produced young and these matured, reach the astonishing number of three thousand millions. The rate of increase is undoubtedly extraordinary, and the figures given serve in a general way to explain why so small an insect can quickly become so very destructive. The millions of minute mouths constantly engaged in pumping out the sap drain infested plants of the materials they elaborate for their own growth and sustenance, and the result is a gradual decline and ultimate death. The injury may not be ac-

accompanied by any unusual growth, though badly infested twigs and fruit are sometimes deformed, but the tissue of both bark and fruit about the attacked scales often assumes a quite characteristic reddish color.

SAN JOSE SCALE ESPECIALLY LIABLE TO BE DISTRIBUTED FROM NURSERIES.

Unlike many other insect pests which frequent nurseries, this scale insect remains on the trees all the year round. It is present on the twigs of young trees when these are shipped in the fall and spring. Otherwise than by this means it does not spread very rapidly, and hence it is believed that a rigid inspection of nursery stock will in great measure restrict it to localities in which it is now established.

THE DETECTION OF SAN JOSE SCALE.

While the San Jose scale may be recognized with a useful degree of certainty by any intelligent man who is provided with a good hand magnifier and has a definite idea of its appearance, it is a rather difficult matter to decide positively the question of species, because of the presence on certain fruits of scale insects belonging to the same genus (*Aspidiotus*), and of very similar appearance. Some little familiarity with the use of the compound microscope is necessary, as well as a knowledge of methods of preparing small objects for microscopic examination. It is best for the practical man when in doubt to submit the question for definite determination to some one who has at hand conveniences for doing this kind of work. The Experiment Station at Lexington will make such examinations free of charge. Those sending us infected twigs for examination are requested to enclose them carefully in tight boxes. A small piece of infested twig which can be sent through the mail will be sufficient for the purpose.

DESCRIPTION.

The female scale is nearly circular in outline, rather flat, and has a small round nearly central cap. It varies in diameter from 1-25 to 2-25 inch. It is so closely fastened to the bark commonly that its outer margin is not clearly apparent even under a hand magnifier. The color varies from gray to reddish brown and dark ash.

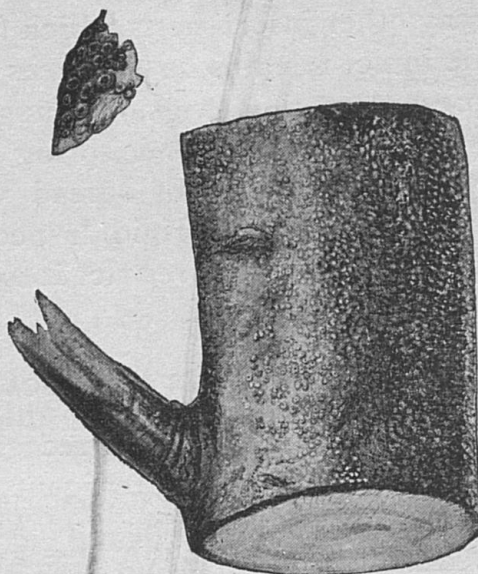


FIG. 1. Showing the San Jose Scale as seen on the bark of twigs. Natural size.

These female scales are the ones most likely to attract attention, and constitute the greater part of the layers which occur on bark. They are not likely to be confounded with any of the common scale insects occurring on fruit trees except, as already noted, members of the genus *Aspidiotus*. The oyster-shell bark louse, common North, but not very common in Kentucky, is much larger and shaped like a rather slender oyster shell. The scurfy bark louse of apple, a common scale on Kentucky fruit trees, is also larger, averaging about 1-10 inch in length, is much longer than wide, and is of a dirty white color, the color alone being sufficient commonly for its recognition.

The male scale is only about half the size of the female scale and is oval in shape, and averages darker in color.

In searching for the San Jose scale the characters to be kept in mind are:

1. The circular, very slightly convex, female scale, with central cap or nipple.
2. The small size, averaging less than .1-.10 inch in diameter.
3. The obscure color, not contrasting sharply with the color of the bark, except when very abundant, in which case the natural glossy surface of healthy twigs gives place to a slightly roughened, scurfy coat, of a grayish color, consisting of the crowded and overlapping scales.
4. The reddish color produced about the scale on young twigs and fruit, and in the inner layer of bark.
5. The destructive effect of the attack.

LIFE HISTORY.

Once established on the bark the female insect remains at all times under her scale, and never changes position. In the spring of the year the male insect comes out from under its scale as a winged fly of very minute size, so small indeed is it that it is rarely seen even by entomologists. The females begin to produce living young in May, and continue to give birth to offspring for a period of about six weeks. The young of both sexes are active for a short time, and leave the shelter of the mother's scale provided with legs and feelers much like those of ordinary insects. They run about with considerable activity at this time searching for a suitable place on the bark to insert their beaks and settle down to the sedentary life of the adults. Some of them find their way upon the feet of birds and are thus carried to other trees. They are very likely to make their way to trees growing close beside the infested ones.

Most of them, however, become fixed to the bark of the tree upon which they were born. It is said that they attach themselves to the bark in a few hours after leaving the mother's scale. The young are about twice as long as wide, and are of a yellow color. As soon as they become fixed to the bark the body shortens, and the

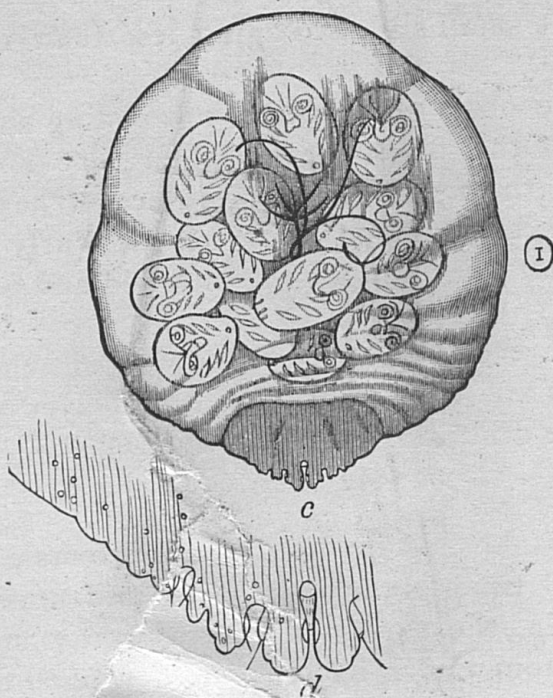


FIG. 2. *c*, Female San Jose Scale removed from under scale and greatly enlarged. *d*, Hind margin of body as seen under compound microscope.

small circular cap or nipple, so noticeable on the fully formed scales, is developed on their backs. They do not subsequently move about, but the males become elongated and later yield the winged flies as already recounted.

The females become mature and are ready to produce young in about one month. The males mature several days earlier. According to the excellent account* of the

* Bulletin 3 (new series) U. S. Dep. Agr., Division of Entomology, 1896.

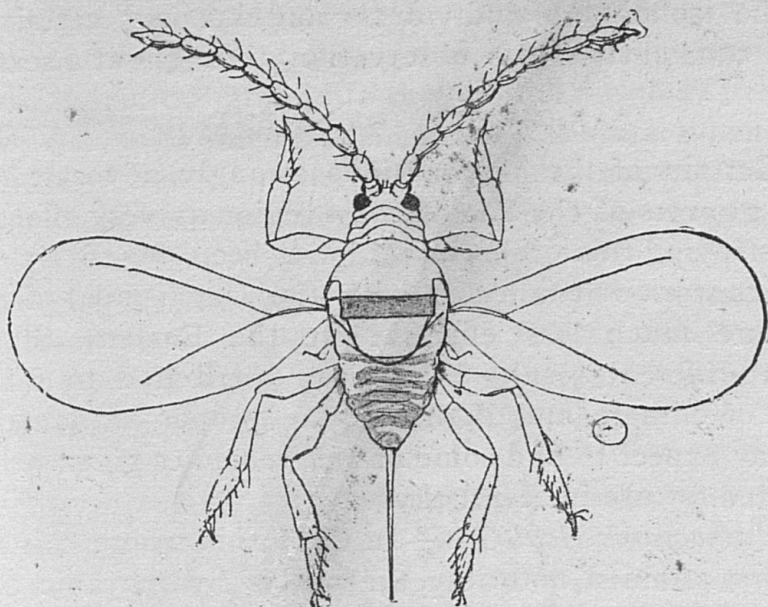


FIG. 3. The male San Jose Scale. Greatly enlarged.

insect published by Messrs. Howard and Marlatt of the United States Department of Agriculture, four generations develop in a season, and as a single female was observed by them to produce as many as 585 young it will be seen that the total number of offspring of one individual would by the end of a season reach startling proportions. The authors mentioned estimate that one female San Jose scale may produce in a season 3, 216, 080, 400 descendants, and in this connection remark. "It is not to be expected, of course, that all the individuals from a scale will survive and perform their functions in life, but under favorable conditions, or in the case of a tree newly infested or not heavily encrusted, the vast majority undoubtedly go through their existence without accident."

The period for reproduction is so prolonged that at almost any time during the summer the insect can be found in all its form and stages of growth, and the facts concerning the number of broods and the number of offspring produced by one individual have only been learned

by the isolation of individuals and keeping certain of them constantly under observation throughout a season.

REMEDIAL TREATMENT.

Certain of the preparations strongly advocated by fruit growers of the Pacific coast region as very effective in destroying this scale insect have been found by the Eastern workers connected with the Department of Agriculture much less effective in the Eastern States. These different results have been attributed to differences of climate, and if this is the proper explanation we may expect to find some of the remedies given below unsuited for use in Kentucky.

Hydrocyanic Acid Gas.—In California where this insect first attained notoriety, the use of hydrocyanic acid gas has been very generally adopted and is highly recommended by practical fruit growers. Gas treatment is theoretically one of the most perfect devised against injurious insects. The fumes can be made to penetrate every crevice of bark and foliage, so that they can be expected to destroy every insect present. The only practical difficulty in the way of its use is the labor and cost of making and handling tents of a size sufficient to cover fruit trees of large size. The difficulty is met in California by leaving the work of treatment to men who make a business of it, going from farm to farm with tents, derricks for operating the same, and supplies of the chemicals necessary for generating the gas.

Fruit growing as a business is perhaps not at present sufficiently general in Kentucky to warrant any one in undertaking the business, but the treatment of small trees with gas is less difficult and requires much less outlay, and will undoubtedly come into favor as a means of ridding young trees, and especially nursery stock, of the pests they harbor.

The trees are covered with sheets or tents made of eight-ounce duck, painted with linseed oil and yellow

ochre to make them gas tight. They are thrown over the trees by the aid of light poles, and the edges are then pressed upon the ground to prevent the escape of the gas. Since this is lighter than air, it rises at once when generated, and hence special precautions for closing the tent at the bottom are not required. A few pieces of wood, or a little earth, thrown upon its edges will be sufficient.

The materials required to produce the gas under the tent are :

1. Fused cyanide of potassium (58 per cent. pure).
2. Sulphuric acid (commercial).
3. Water.

For every 180 cubic feet enclosed is required 1 ounce of the cyanide of potassium, 1 fluid ounce of sulphuric acid and 3 fluid ounces of water. An open stone jar is put under the edge of the tent, and the sulphuric acid and water are poured into it. Then the cyanide is added quickly and the tent closed. The fumes escape at once, and are left about the enclosed tree from fifteen to forty minutes, the time required varying with the size of the tree and the thickness of its foliage.

It is important to remember in using the gas that cyanide of potassium and sulphuric acid are poisonous, and should be kept in jars plainly marked with the word *poison*.

It is important also to keep in mind the fact that cyanide of potassium loses "strength" when exposed to the air, and the substance should therefore be kept in a cool place and in air-tight receptacles. To be used successfully as above recommended it must be of the strength given (58 per cent.), and purchasers should insist upon this when buying. The best time to apply the gas is at night, in the evening, or during cloudy weather, since the experience of California fruit growers shows that trees are less liable to injury at such times than when fumigated in bright sunlight.

The cost of treatment with gas is slightly greater than by spraying, but Mr. D. W. Coquillett, of the Department of Agriculture, after extensive experience in such work in California writes: "At the present price of the chemicals used the cost of treating citrus trees with this gas will vary from 5 cents to \$1 per tree. This latter sum may seem an exorbitant one to pay for ridding an orange tree of the scale insects that infest it, and yet our fruit growers find themselves well repaid for expending so large a sum of money for this purpose. At a recent meeting of the County Horticultural Commissioners, Mr. B. J. Perry reported having treated 47,000 citrus trees at an average expense of less than 25 cents per tree. This is but slightly in excess of what it would cost to spray them, and this slight difference in the cost is more than counterbalanced by the better results obtained, the less labor involved, and the better condition the trees are left in after the operation is completed."

The San Jose scale can be treated best with this gas in the fall and winter when the leaves are gone, and the cost of treatment under these conditions is considerably less than when trees are loaded with leaves. In treating 326 trees and shrubs infested with San Jose scale at Charlottesville, Virginia, Mr. Coquillett expended \$30.19, making an average of a little over 9 cents for each one. His itemized list of expenditures is instructive, and will serve as a guide to those who may wish to use the gas. It is as follows:

42 pounds cyanide, at 39 cents per pound.....	\$16 38
90 pounds sulphuric acid, at 3½ cents per pound	3 15
4 men 2⅔ days, at \$1 each per day	10 66
Total	\$30 19

In the case of nursery stock the cost of treatment can be still further reduced by fumigating large numbers of young trees at the same time, after they have been taken

up and healed in. The process is recognized by our best authorities as especially adapted for use in the nursery.

Salt Lime Sulphur Solution.—This preparation is in favor with many California fruit growers as a remedy against San Jose scale. A formula for its preparation recently furnished to the Department of Agriculture by Mr. H. B. Muscott, Chairman of the San Bernardino County Board of Horticultural Commissioners, is as follows :

Forty pounds of lime (unslacked), 20 pounds sulphur, 15 pounds coarse salt.

Add 40 gallons of water to the above materials, stirring thoroughly while the lime is slacking. Boil fully three hours, then add enough water to make 80 gallons of the solution, then strain through burlaps and apply warm. Use only on deciduous trees and when said trees are dormant.

Mr. Coquillet, of the Department, did not, however, when in California find this preparation as effective as it is sometimes claimed to be, and from recent experience with the scale the entomologists at the National Department of Agriculture have reached the conclusion that this and certain other washes recommended for use in California are not effective in the East.

Kerosene Emulsion.—This is a standard remedy for such insects as San Jose scale, but appears not to be as effective as the soap wash given below. It is commonly prepared as follows :

Coal oil, 2 gallons.

Soap (whale oil), $\frac{1}{2}$ pound.

Water, 1 gallon.

The soap is dissolved in 1 gallon of hot water, and at once thoroughly churned with the coal oil by passing it through a force pump and returning it to the vessel whence it is pumped. Soaps other than the above are sometimes substituted, but they vary to such an extent

in composition that there is some danger of getting an imperfect emulsion with their use. A quart of soft soap may be used in place of whale oil soap.

It is customary to dilute the above quantity of emulsion with 3 to 4 times as much water before applying it to the leaves of plants. For use in winter against insects on the naked branches it may be used stronger, without injury to the trees.

Soap Solutions.—Solutions made by dissolving soap in hot water have been strongly recommended recently by Drs. Howard and Marlatt, after an extended experience with the San Jose scale, in the course of which they have made most thoroughgoing comparative tests of the different washes recommended by western fruit growers. A solution consisting of two pounds of whale oil soap in one gallon of water, should according to these authors be sprayed upon infested trees in the fall or spring, so that every part is thoroughly drenched. Applications made in the fall may have the effect of preventing fruiting the following season. Applications made in the spring, even when trees are in partial bloom, have been found to do no special injury.

The soap used should be of uniform grade, and it will be best always to get whale oil soap where possible, since it has been proved to be well suited for the purpose. Bought in large quantities it costs about 4 cents per pound, in smaller quantities (100 pounds or less) it sells for about 6 cents per pound.

LEGISLATION AGAINST SAN JOSE SCALE.

This subject has been much discussed of late at meetings of the horticultural societies, by fruit growers, nurserymen, and Station workers, throughout the United States, and the opinion seems to be general that laws are needed to check the further spread of San Jose scale.

Nurserymen were among the first to recognize the fact that their interests were identical with those of the fruit grower in this matter. Systematic inspection of nursery stock has been very generally decided on as the only feasible plan of securing anything approaching safety in this regard, and bills have now been framed for presentation to the Legislative Assemblies of most of the States likely to suffer severely from invasion, the basis of which is inspection by State Entomologists. In a number of States such laws have already been adopted, and the probability is that in the course of the next three or four years every State in the Union will have such a law in operation. Kentucky should not be behind her sister States in protecting the interests of her fruit growers, and it is to be hoped that the resolution adopted by our State Horticultural Society at its last meeting requesting the Governor of the Commonwealth to include the consideration of this subject in his call for a special session of the General Assembly may lead to the passage of an effective law requiring that no infested nursery stock shall be shipped to buyers in this State.

There can be no question about the need of such legislation. That is conceded by everybody concerned. Nor should there be any concerning the necessity of immediate action. Professor S. A. Forbes, Chairman of the Committee on Entomology of the American Association of Agricultural Colleges and Experiment Stations, writes in a recent letter:

"Action cannot be taken too soon in this direction, since danger of the importation, establishment and spread of injurious insects and fungus diseases of fruits increases rapidly with the very great increase in interstate and international commerce in fruits and nursery stock. The nursery business is being largely revolutionized by specialization, each kind of stock being grown

most generally in some region especially adapted to it and thence shipped far and wide on the orders of nurserymen.

Imminent danger of the introduction of the San Jose scale has greatly stimulated this movement, and those States that are prompt and energetic are the ones which are most likely to escape great horticultural losses. I am glad to see that Kentucky people are moving in this direction, and hope that their efforts to protect themselves against invasion from without and to prevent the multiplication and spread of the fruit pests already established in that State may be successful."

State legislation alone can not be expected to protect us from the inroads of pests imported on nursery stock from foreign countries. A large number of the most troublesome species have been brought to this country in this manner. It is important that there should be inspection, under Federal authority at ports of entry. A bill recently framed by a National Convention (held at Washington, D. C., March 5 and 6, 1897) of fruit growers, nurserymen and Station workers, providing for such inspection, has been presented to Congress. This convention made the following recommendations with reference to State legislation against insect and fungus pests:

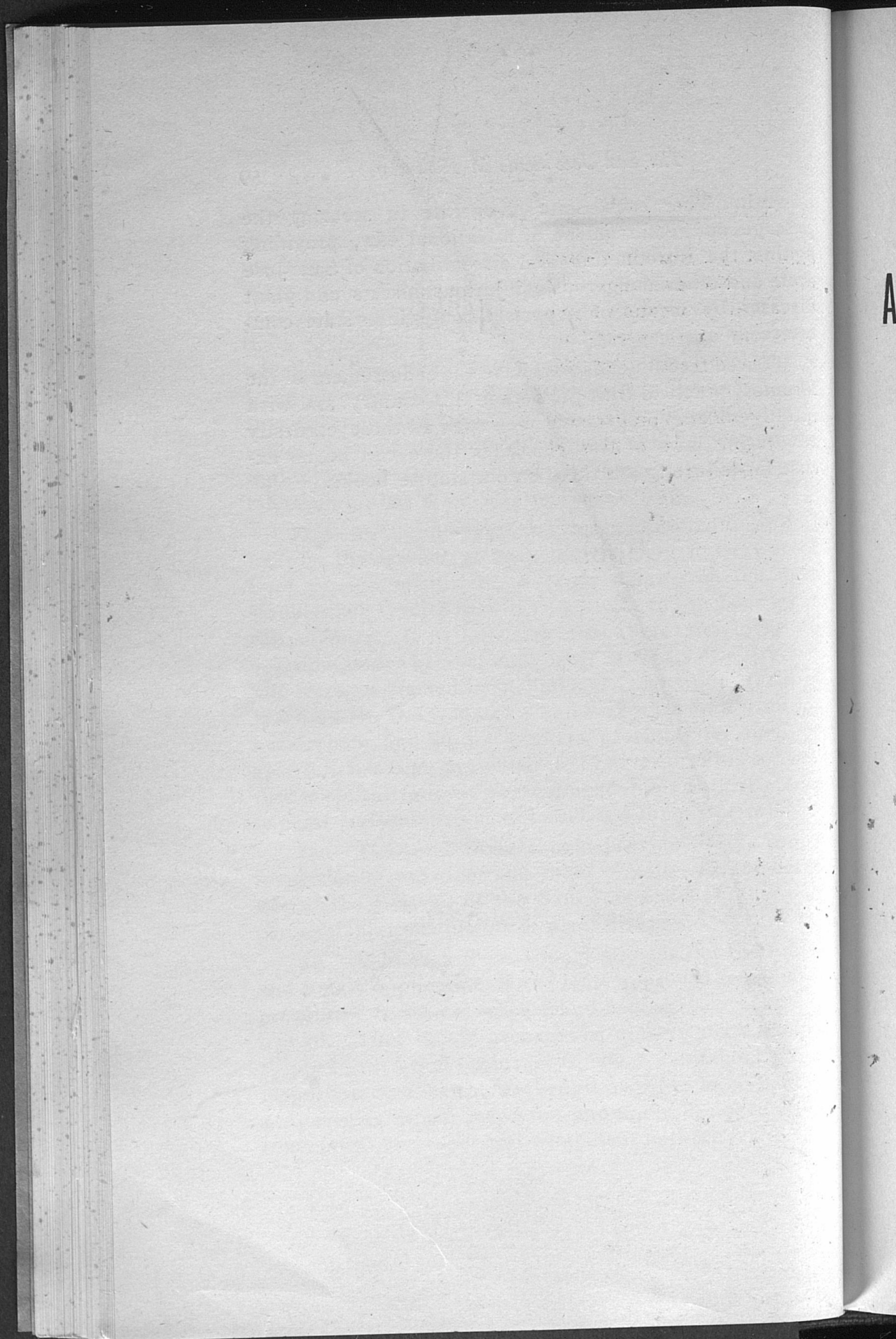
1st. That each State should provide for the proper inspection of nurseries and other premises for the detection of the presence of the San Jose scale, or other dangerously injurious insects or plant diseases.

2d. That each State should provide for the proper and timely application of the most approved remedial or preventive treatment when found necessary.

3d. That should packages of nursery stock, etc., be shipped into a State contrary to law, *i. e.*, without proper inspection certificates attached, it ought to be so handled as to receive proper inspection and not be destroyed unless condemned by proper and competent authority.

4th. That each State co-operate in securing the passage and enforcement of a National law, providing against the introduction and dissemination of San Jose scale and other dangerously injurious insects and plant diseases by means of imports through inter-state commerce.

These recommendations have the endorsement of the foremost practical fruit growers in this country, and with intelligent and progressive men such as these earnestly advocating laws of this character there can be no excuse for failure to put them on our statute books.



KENTUCKY
AGRICULTURAL EXPERIMENT STATION

OF THE

STATE COLLEGE OF KENTUCKY.

BULLETIN NO. 68.

Analyses of Commercial Fertilizers.

LEXINGTON, KENTUCKY,

May, 1897.

KENTUCKY

Agricultural Experiment Station.

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KENTUCKY AGRICULTURAL EXPERIMENT STATION,
LEXINGTON, KY.

BULLETIN NO. 68.

ANALYSES OF COMMERCIAL FERTILIZERS.

For the more important principles on which the intelligent use of fertilizers depends, and for information in regard to the materials of which commercial fertilizers are made, we refer the reader to Bulletins Nos. 41, 46 and 51. This bulletin contains all the "official analyses" for the year 1897 up to the present date, with only such brief explanations as seem necessary for the right understanding of the figures.

Explanations in Regard to the Tables.

For convenience, the analyses in this bulletin are arranged in two tables:

Table I. contains ground bones, ammoniated bones, etc.

Table II., those fertilizers whose phosphatic materials have been acted upon by sulphuric acid in order to render the phosphoric acid in them more soluble.

The finer a bone is ground the more valuable it is. For this reason we divide ground bone into "fine bone" and "medium bone" and give the amount of phosphoric

acid in each separately in the tables. In computing the estimated value, the phosphoric acid in the "fine bone" is given a greater value than that in the "medium bone."

In Table II., the phosphoric acid is stated as "soluble," "reverted" and "insoluble" phosphoric acid, the sum of these representing the total amount of phosphoric acid in the fertilizer. The sum of the "soluble" and "reverted" is "available" phosphoric acid, or the phosphoric acid that is of immediate use to plants.

In this table is also given the nitrogen, as well as its "equivalent in ammonia," or, in other words, the greatest amount of ammonia which would be possible to be made from the nitrogen: also the amount of potash either in the form of sulphate or muriate or both. As sulphate of potash is somewhat more costly than muriate, it is thought best to give the form in which the potash is found in the fertilizers analyzed.

The "Estimated Value Per Ton."

The fertilizer law requires that the Director shall give, along with the analysis of each fertilizer, "the money value of such fertilizer computed from its composition, as he may determine." This is the "estimated value per ton" given in the last column of the tables.

The words of the law, "the money value of such fertilizer, computed from its composition" define as nearly as possible what these "estimated values" are intended to represent; that is, they are intended to show what the phosphoric acid, nitrogen and potash in a ton of each fertilizer is actually worth in dollars and cents. In other words, they are intended to show about how much the raw materials necessary to furnish the same quantity of "essential ingredients" as is found by the analysis would cost if purchased separately and then combined. It is important to note, however, that on account of the differences in the prices of the different materials which may be used to furnish phosphoric acid, nitrogen and potash, and differences in the price of the same material at different times, as well as differences in rates of freight to the different points in the state, it is practically impossible to make these "estimated values" represent exactly the money value of the fertilizers. At best they are only relatively correct.

In order to calculate these values from the analyses, the Director assigns each year a certain price per pound for each of the "essential ingredients" of fertilizers. These prices are based upon the New York prices of the principal materials of which fertilizers are made and include an allowance for freight from New York and for cost of mixing and loss in handling.

The framers of the fertilizer law evidently intended these estimated values to be an index that would show at a glance whether the purchaser was getting the worth of his money, and in a general way they do serve this purpose. Thus, when the "estimated value per ton" is very much below the price at which a ton of the fertilizer is sold, it shows that the purchaser at this price is paying high for the plant food it contains. But the estimated value alone is not a sufficient guide in purchasing fertilizers; it is necessary to consider the analysis also.

Importance of the Analyses

In purchasing fertilizers it is of the first importance to consider the analyses, either in the tables of the bulletin or on the tags which should always be found attached to each sack; for by the analysis only can we tell whether we are getting, in the fertilizer, the plant food that we want to supply to our crop. If we were selecting a fertilizer for corn, for instance, to be used on a soil that was rich in phosphates but deficient in potash, we certainly would not buy a so-called "Corn Grower" that contained no potash, even if it was offered at a price much lower than the "estimated value."

Let us illustrate this farther by example: Suppose that a farmer, desiring to purchase a fertilizer for his corn crop, is offered by his merchant either of two "corn growers" at \$25 per ton. The price, fortunately, does not help him to decide in this case. Next he looks at the tags attached to the sacks, and finds that the Director has estimated

the value of each fertilizer at \$25.20 per ton. He next looks at the analyses and finds that fertilizer No. 1 contains :

Soluble Phosphoric Acid,	}	12.0 per cent.
Reverted " "		
Potash		None.
Nitrogen		2.4 per cent.

And Fertilizer No. 2 contains :

Soluble Phosphoric Acid,	}	 6.0 per cent.
Reverted " "		
Nitrogen		2.4 per cent.
Potash, from muriate		7.0 per cent.

He is now able to judge which of the two fertilizers to purchase. If his soil needs phosphoric acid, he will quickly decide on No. 1, for he will get twice as much for the same money, while did he purchase No. 2 he would get only half as much phosphoric acid which he needs and would be paying for potash which he does not need. But if he is in doubt whether his land needs one or all the elements of a fertilizer, or if he knows that his land needs potash, he will be wise in purchasing No. 2. For should his soil need potash, or all three of the essential elements to produce a large corn crop, and should he purchase No. 1, it is doubtful whether he would receive any benefit from it.

Values Used.

The values for the "essential ingredients" in 1897 are as follows :

Soluble and reverted phosphoric acid in mixed fertilizers, 7 cents; in plain acid and unacidulated phosphates, 5 cents per pound.

Insoluble phosphoric acid in mixed fertilizers, 2½ cents; in plain acid phosphates, nothing; in Orchilla guano, 3 cents; in other unacidulated phosphates, 2 cents per pound.

*Phosphoric acid in fine bone, 4 cents; in medium bone, 3 cents per pound.

Nitrogen in all fertilizers, 17½ cents per pound.

Potash in all fertilizers, from sulphate, 7 cents; from muriate, 6 cents per pound.

*Fine Bone is all that passes through a sieve with meshes 1-25 inch square. Medium bone passes through a sieve with meshes 1-6 inch square, but does not include fine bone.

TABLE I.—Raw Bone Manures.

Station Number.	NAME AND ADDRESS OF MANUFACTURER.	NAME OF BRAND.	POUNDS IN THE HUNDRED.							Estimated Value Per Ton.
			PHOSPHORIC ACID.			Equivalent to Bone Phosphate.	Nitrogen.	Equivalent to Ammonia.		
			In Fine Bone	In Medium Bone.	Total.					
3660	The Armour Fertilizer Works, Chicago, Ill.	Bone Meal	21.45	3.21	24.66	53.87	3.41	4.14	\$31 03	
3661	Same	Raw Bone Meal	14.52	11.04	25.56	55.82	3.84	4.66	31 68	
3734	Globe Fertilizer Co., Louisville, Ky.	Globe Bone Meal.....	16.18	8.33	24.51	53.53	3.59	4.36	30 51	
3652	W. A. Guenther & Sons, Owens- boro, Ky.....	Bone Meal.....	21.46	3.23	24.69	53.92	3.33	4.04	30 77	
3781	J. B. Jones, Louisville, Ky.....	Raw Bone Meal.....	13.58	8.32	21.90	47.83	3.53	4.29	28 21	
3798	Same.....	Ammoniated Bone.....	11.57	1.58	13.15	28.72	2.66	3.23	19 52	
3635	The Jones Fertilizing Co., Cin- cinnati, O.....	Pure Raw Bone Meal	4.23	21.43	25.66	56.05	3.91	4.75	29 93	
3636	Same.....	Fine Ground Bone.....	18.25	6.75	25.00	54.59	3.48	4.22	30 83	
3638	Same.....	Ammoniated Bone Meal	16.30	1.28	17.58	38.39	4.83	5.86	30 72	

TABLE I.—Raw Bone Manures (Concluded).

Station Number.	NAME AND ADDRESS OF MANUFACTURER.	NAME OF BRAND.	POUNDS IN THE HUNDRED.						Estimated Value Per Ton.
			PHOSPHORIC ACID.			Equivalent to Bone Phosphate.	Nitrogen.	Equivalent to Ammonia.	
			In Fine Bone	In Medium Bone	Total.				
3740	Michigan Carbon Works, Detroit, Mich.....	Desiccated Bone.....	25.54	6.19	31.73	69.29	1.50	1.82	\$29 39
3672	North-Western Fertilizing Co., Chicago, Ill.....	Horse Shoe Brand Fine Raw Bone.....	17.99	4.96	22.95	50.12	3.89	4.72	30 99
3679	Same	H. S. B. Pure Ground Bone.....	17.30	2.61	19.91	43.47	3.35	4.07	27 14
3719	Swift & Company, Chicago, Ill...	Pure Raw Bone Meal.....	18.95	6.25	25.20	55.04	4.27	5.18	33 86
3720	Same.....	Ground Steamed Bone.....	25.30	2.20	27.50	60.07	2.65	3.22	30 84
3721	Same	Bone Tankage.....	16.98	2.03	19.01	41.52	4.96	6.02	32 16
3722	Same	Bone and Potash.....	24.15	1.54	25.69	56.10	2.46	2.99	32 85*
3723	Same	Bone Tankage and Potash	15.42	1.93	17.35	37.89	4.83	5.86	34 40†

*Potash from sulphate 2.87 per cent.

†Potash from sulphate 2.85 per cent.

TABLE II.—Complete Fertilizers, Superphosphates, Etc.

TABLE II.—Complete Fertilizers, Superphosphates, Etc.

Station Number.	NAME AND ADDRESS OF MANUFACTURER.	NAME OF BRAND.	POUNDS IN THE HUNDRED.								Estimated Value Per Ton.
			PHOSPHORIC ACID.			Nitrogen.	Equivalent to Ammonia.	POTASH.			
			Soluble.	Reverted.	Insoluble.			From Sulphate.	From Muriate.		
3821	A. D. Adair & McCarty Bros., Atlanta, Ga	Farish Furman Formula	10.67	1.99	2.37	.....	.....	.....	3.07	\$22 59	
3659	The Armour Fertilizer Works, Chicago, Ill	White Burley and Black Tobacco	2.29	6.48	3.45	3.12	3.79	4.93	.....	31 83	
3662	Same	Acidulated Bone Meal	5.01	10.66	6.18	2.63	3.19	.....	.....	34 24	
3664	Same	Grain Grower	5.53	3.87	0.87	1.79	2.17	.....	1.83	22 07	
3665	Same	Bone, Blood and Potash	6.12	3.63	1.38	4.94	6.00	7.73	.....	42 45	
3726	Same	Ammoniated Bone with Potash	5.13	4.24	3.24	3.32	4.03	2.50	.....	29 86	
3799	Geo. S. Bartlett, Cincinnati, Ohio	Indian Brand Ohio Valley Phosphate	7.28	3.42	3.51	2.02	2.45	.....	2.00	26 21	
	Same	Indian Brand Gilead Phosphate.*									
3810	The Cleveland Dryer Com- pany, Cleveland, O	Buckeye Ammoniated Bone Superphosphate	7.02	3.06	3.47	2.91	3.53	.....	0.51	26 65	

*This sample was withdrawn by the manufacturer on account of an error at factory in mixing and will be replaced by another, the analysis of which will appear in next fertilizer bulletin.

TABLE II.—Complete Fertilizers, Superphosphates, Etc. (Continued.)

NAME AND ADDRESS OF MANUFACTURER.		NAME OF BRAND.	POUNDS IN THE HUNDRED.							Estimated Value Per Ton.
			PHOSPHORIC ACID.			Nitrogen.	Equivalent to Ammonia.	POTASH.		
			Soluble.	Reverted.	Insoluble.			From Sulphate.	From Muriate.	
Station Number.										
3811	The Cleveland Dryer Com- pany, Cleveland, O	Ohio Seed Maker.....	5.92	4.66	3.79	1.80	2.19	.....	.....	\$23 01
3812	Same	White Burley Tobacco Fer- tilizer	7.16	2.21	3.88	2.94	3.57	.....	2.99	28 94
3813	Same	Ammoniated Dissolved Bone	5.91	4.67	3.72	1.80	2.19	.....	.....	22 97
3814	Same	Square Bone	3.11	10.04	9.31	2.59	3.14	.....	.....	32 14
3815	Same	Phospho Bone.....	6.67	2.78	2.09	1.14	1.38	.....	1.44	20 00
3816	Same	XXX Phosphate	3.40	9.78	2.38	.....	.....	.....	.....	18 18
3817	Same	Ohio Seed Maker and Potash	6.47	3.35	4.03	1.66	2.02	.....	2.78	24 92
3818	Same	Horsehead Phosphate.....	7.41	3.08	1.28	.....	.....	.....	.....	10 49
3727	The Currie Fertilizer Com- pany, Louisville, Ky	Currie's Special for Corn and Oats	7.11	1.88	0.81	0.92	1.12	2.87	.....	20 24
3771	Same	Same	5.05	3.11	1.15	0.96	1.17	3.10		19 70

3728	Same	Currie's Golden Leaf Tobac-	7 37	2 37	1 47	1 18	1 43	3 68		23 66
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Analyses of Commercial Fertilizers.

3728	Same	Currie's Golden Leaf Tobacco Grower	7.37	2.37	1.47	1.18	1.43	3.68		23 66
3729	Same	Currie's Soluble Bone.....	7.04	1.72	0.83	0.91	1.10	2.83	.....	19 83
3772	Same	Same	8.07	3.78	1.54	0.72	0.87	2.91	.....	23 95
3730	Same	Currie's Butchertown Raw Bone Meal	5.27	5.74	4.41	0.95	1.15	1.25	.....	22 70
3731	Same	Currie's Wheat Special	9.19	3.17	1.87	.....	.....	.....	.....	12 36
3732	Same	Currie's Climax Tobacco Grower	7.09	1.84	0.75	0.89	1.08	2.81	.....	19 93
3691	Globe Fertilizer Co., Louisville, Ky.....	Globe Potato Grower.....	6.73	1.54	1.52	3.95	4.80	4.57	.....	32 57
3692	Same	Globe Soluble Vegetable Manure	7.96	1.36	0.84	3.41	4.14	3.65	.....	30 52
3693	Same	Kentucky Standard Tobacco Grower	7.97	1.34	0.90	3.43	4.16	3.62	.....	30 56
3694	Same	Big Four Tobacco Grower.....	7.88	1.25	1.07	2.25	2.73	2.77	.....	25 08
3695	Same	Eagle Corn and Wheat Grower	8.17	1.67	1.39	2.34	2.84	2.74	.....	26 51
3697	Same	Globe Bone Dust.....	8.71	2.35	1.84	1.35	1.64	0.48	.....	21 80
3698	Same	Globe Bone and Potash.....	11.42	1.85	1.07	0.38	0.46	1.35	.....	22 34
3699	Same	Globe Wheat Grower	8.16	1.70	1.23	2.31	2.80	2.63	.....	26 19
3700	Same	Golden Harvest Bone Meal.....	7.65	2.70	2.97	3.11	3.78	0.46	.....	27 51
3735	Same	Progress Corn and Wheat Grower	8.65	1.03	0.90	2.15	2.61	1.62	.....	23 80
3689	I. B. Jones, Louisville, Ky....	Tobacco and Potato Grower..	3.22	3.48	2.05	3.02	3.67	8.23	.....	32 50

TABLE II.—Complete Fertilizers, Superphosphates, Etc. (Continued.)

POUNDS IN THE HUNDRED.										
Station Number.	NAME AND ADDRESS OF MANUFACTURER.	NAME OF BRAND.	PHOSPHORIC ACID.			Nitrogen.	Equivalent to Ammonia	POTASH.		Estimated Value Per Ton.
			Soluble.	Reverted.	Insoluble.			From Sulphate.	From Muriate.	
3637	The Jones Fertilizing Co., Cincinnati, O.....	Acidulated Bone	6.97	5.18	4.76	2.92	3.54	.....	.....	\$29 61
3643	Same	Jewel Phosphate	7.50	2.43	2.97	1.81	2.20	.....	.....	21 73
3760	Same	Special Tobacco Grower	2.81	4.47	3.91	2.65	3.22	3.13	.....	25 81
3761	Same	Tobacco and Potato Grower..	3.95	3.91	3.79	4.32	5.24	6.27	.....	36 80
3762	Same	Jones' Reliable.....	2.60	4.20	3.59	2.41	2.93	1.67	.....	22 10
3763	Same	Miami Valley Phosphate.....	2.83	4.37	4.22	2.68	3.25	2.61	.....	25 22
3746	A. B. Mayer, Mfg. Co., St. Louis, Mo.....	Anchor Brand Complete Fer- tilizer.....	3.36	4.77	3.35	2.76	3.35	3.69	.....	27 89
3736	Michigan Carbon Works, De- troit, Mich.....	Homestead Corn and Wheat Grower	7.98	1.68	1.71	2.49	3.02	.....	2.22	25 76
3737	Same	Homestead Tobacco Grower.	9.74	0.58	1.13	3.29	3.99	.....	4.18	31 56
3738	Same	Jarves' Drill Phosphate.....	7.42	2.22	0.58	1.34	1.63	.....	1.12	19 82
3739	Same	Jarves' Tobacco Fertilizer.....	5.46	1.13	0.50	1.90	2.31	.....	2.33	18 93

3739	Same	Jarves' Tobacco Fertilizer.....	5.46	1.13	0.50	1.90	2.31	.....	2.33	18	93
3773	Same	National Fertilizer Co., Nashville, Tenn.....	10.64	5.93	1.24	.....	.....	.....	.....	16	57
3774	Same	Acid Phosphate.....	9.62	6.21	1.11	.....	.....	.....	2.91	26	21
3775	Same	Acid Phosphate with Potash	6.29	4.09	2.84	2.03	2.46	0.75	1.70	26	15
3776	Same	Tobacco Grower.....	7.93	5.48	2.10	0.82	1.00	0.38	0.60	23	94
3777	Same	Corn Grower.....	7.60	2.52	1.79	2.59	3.14	.....	4.30	29	30
3673	Same	Tobacco Fertilizer.....	5.19	2.56	2.69	3.37	4.09	3.42	.....	28	79
3674	Same	Horse Shoe Brand Tobacco Grower.....	4.80	2.62	2.81	2.58	3.13	2.23	.....	23	95
3675	Same	H. S. B. Challenge Corn Grower.....	4.30	2.48	2.62	1.82	2.21	1.63	.....	19	45
3676	Same	H. S. B. Prairie Phosphate... H. S. B. Kentucky Tobacco Grower.....	4.54	2.65	4.26	2.87	3.48	2.31	.....	25	48
3677	Same	H. S. B. Potato Grower.....	6.96	2.15	0.74	2.59	3.14	2.71	.....	25	98
3678	Same	H. S. B. Ky-Ana Phosphate	4.67	2.47	2.15	1.17	1.42	.....	.....	15	18
3680	Same	H. S. B. Raw Bone and Super Phosphate Mixture.....	3.71	4.28	7.71	3.12	3.79	0.75	.....	27	02
3681	Same	H. S. B. High Grade Truck Manure.....	4.93	2.45	2.66	3.81	4.63	3.14	.....	29	40
3682	Same	H. S. B. Quick Acting Phosphate.....	9.80	2.71	3.17	.....	.....	.....	.....	12	51
3683	Same	H. S. B. Dissolved Bone Phosphate.....	9.58	3.06	0.93	1.23	1.49	.....	.....	22	48
3684	Same	H. S. B. Corn and Wheat Grower.....	7.71	2.77	2.15	2.46	2.99	1.34	.....	26	24
3686	Same	H. S. B. Acidulated Bone and Potash.....	7.71	2.81	2.16	0.79	0.96	2.43	.....	21	98

TABLE II.—Complete Fertilizers, Superphosphates, Etc (Concluded).

Station Number.	NAME AND ADDRESS OF MANUFACTURER.	NAME OF BRAND.	POUNDS IN THE HUNDRED								Estimated Value Per Ton.
			PHOSPHORIC ACID.			POTASH.					
			Soluble.	Reverted.	Insoluble.	Nitrogen.	Equivalent to Ammonia.	From Sulphate.	From Muriate.		
3687	North-Western Fertilizing Co., Chicago, Ill	H. S. B. Acidulated Bone.....	8.35	2.95	2.29	0.85	1.03	.....	.....	.....	\$19 95
3688 3785	Same	H. S. B. Bone and Potash.....	8.48	2.57	3.79	0.46	0.56	1.03	.....	.....	20 42
	Read Fertilizer Co., Charles- ton, S. C.....	Blood and Bone Fertilizer No. 1.....	5.82	2.70	2.55	1.96	2.38	.....	2.45	.....	23 01
3809	Same	Alkaline Bone.....	7.42	2.91	2.34	.....	.....	.....	2.27	.....	18 35
	The J. & F. Schroth Packing Co., Cincinnati, O.....	Corn and Wheat Grower.*									
	Same	Queen City Phosphate.*									
	Same	Schroth's Special.*									
3764	Wm. Skene & Co., Louis- ville, Ky.....	Skene's Complete Plant Food	2.87	4.08	1.39	4.18	5.07	15.01	.....	.....	46 07
3765	Same	Skene's Louisville Super- phosphate.	3.66	6.02	1.62	1.10	1.34	5.52	.....	.....	25 94
3826	T. J. Smith, Spurlington, Ky.	Smith's Bone, Potash, and Plant Food	5.51	3.76	4.85	2.30	2.79	1.00	2.82	.....	28 24

3724	Swift & Co., Chicago, Ill.....	Superphosphate.....	1.92	6.77	9.07	2.37	2.88	2.74	.....	.....	28 85
3822	Same	Swift's Special Pure Tobacco Grower .....	.....	6.37	8.78	3.22	3.91	4.81	.....	.....	31 31

3724	Swift & Co., Chicago, Ill.	Superphosphate	1.92	6.77	9.07	2.37	2.88	2.74	.....	28 85
3822	Same	Swift's Special Pure Tobacco Grower	.....	6.37	8.78	3.22	3.91	4.81	.....	31 31
3705	S. W. Travers & Co., Rich- mond, Va.	Capital Dissolved S. C. Bone. Travers Dissolved Bone	9.03	4.16	0.82	.....	.....	.....	.....	13 19
3706	Same	Phosphate	11.00	2.97	0.61	.....	.....	.....	.....	13 97
3707	Same	Capital Bone-Potash Com- pound	7.80	3.25	0.46	.....	.....	.....	1.62	17 64
3708	Same	Champion Corn Grower	6.60	2.83	0.87	0.84	1.02	.....	2.96	20 13
3709	Same	Capital Tobacco Fertilizer	2.84	2.69	1.71	4.89	5.94	10.25	.....	40 07
3710	Same	National Tobacco Fertilizer	6.87	2.18	1.98	1.95	2.37	.....	4.29	25 64
3711	Same	Beef, Blood and Bone Fer- tilizer	6.14	1.53	1.14	2.27	2.76	.....	1.74	21 35
3712	Same	National Wheat and Grass Grower	6.15	1.59	1.16	2.28	2.77	.....	1.69	21 43
3713	Same	Orchilla Guano	.....	5.20	10.16	.....	.....	.....	.....	11 30

* This sample was withdrawn by the manufacturer on account of an error at factory in mixing and will be replaced by another, the analysis of which will appear in next fertilizer bulletin.

MAY 15th, 1897.

M. A. SCOVELL, Director.
A. M. PETER.
H. E. CURTIS.

A

KENTUCKY
AGRICULTURAL EXPERIMENT STATION

OF THE
STATE COLLEGE OF KENTUCKY.

BULLETIN NO. 69.

WHEAT.

1. Test of Varieties.
2. Test of Fertilizers.
3. Descriptions of Varieties.
4. Treatment for Smut.

LEXINGTON, KENTUCKY.
SEPTEMBER, 1897.

KENTUCKY Agricultural Experiment Station.

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NOTICE.

The Bulletins of the Station will be mailed free to any citizen of Kentucky who sends his name and address to the Station for that purpose.

Correspondents will please notify the Director of changes in their post-office address, or of any failure to receive the Bulletins.

ADDRESS:

KENTUCKY AGRICULTURAL EXPERIMENT STATION,
LEXINGTON, KY.

BULLETIN NO. 69.

WHEAT.

The subject is treated under the following heads :

1. Test of Varieties.
2. Test of Fertilizers.
3. Descriptions of Varieties.
4. Treatment for Smut.

The Soil.—The experiments were conducted on the Experiment Station grounds, the character of the soil of which has been described in previous bulletins.

The Season.—The season was a fair one for the wheat crop. The English sparrow, although carefully watched during the ripening season, undoubtedly diminished the yield, and impaired, at least to some extent, the accuracy of the results obtained.

The following table shows the rainfall per month, highest, lowest, and average temperature, and the amount of sunshine during the wheat season :

MONTHS, 1896-1897.	Per Cent. Sunshine.	Clouds.	Amount of Rainfall in Inches.	TEMPERATURE. Degrees.		
				Mean.	Highest.	Lowest.
September	35.0	65.0	4.25	67.4	95	36
October.....	56.0	44.0	1.27	54.4	77	30
November.....	37.0	63.0	4.30	47.6	72	14
December.....	32.0	68.0	2.56	38.4	63	13
January.....	31.0	69.0	2.59	29.9	67	-6
February.....	26.0	74.0	6.33	37.4	66	10
March.....	27.0	73.0	6.55	47.6	76	22
April	37.0	63.0	5.80	53.2	82	26
May.....	47.0	53.0	4.48	59.4	87	33
June.....	41.0	59.0	4.77	72.1	93	50

1. Test of Varieties.

Seventeen varieties were under test. Each variety was planted on $\frac{1}{15}$ acre plot, in drills seven inches apart. The amount of seed sown was at the rate of one and one-fourth bushels per acre. All plots were planted October 12, 1896, and harvested June 28, 1897.

A description of the varieties may be found on pages 87-95, and photographic cuts of the heads of each variety following page 92.

Here follows a table giving the yield of each variety and the weight of wheat per bushel.

Wheat, Yield of Varieties.

	NAME OF VARIETY.	Head	Yield per acre		Weight per bushel, lbs.
		B-- Beard- ed. S-- smooth head.	Grain bushels.	Straw pounds	
1	Jones' Winter Fife	S.	23.	2070	59
2	American Bronze	S.	16.	2190	60
3	Early White Leader	S.	7.3	1215	52
4	Pride of Genesee	B.	21.8	2505	62
5	Oatka Chief	B.	25.3	3210	61
6	Long Amber	S.	20.0	2400	.....
7	Jones Bearded	B.	15	1875	59½
8	Pride	B.	19.5	2205	60
9	Bearded Winter Fife	B.	30.5	3045	63
10	Early Arcadian	S.	27.4	3258	61
11	Pedigreed Early Genesee Giant.	B.	26.8	3120	63
12	Diamond Grit	B.	21.0	3240	63
13	White Golden Cross	B.	27.9	3445	62
14	Lancaster Red	B.	16.9	2213	62
15	Democrat	B.	21.3	3300	63
16	Gold Coin	S.	21.	2820	61
17	Dawson's Golden Chaff	S.	17.	2580	.....

Milling Qualities.

In order to test the different varieties of wheat as to their milling qualities the several samples were submitted

to Mr. C. S. Brent who kindly gave his opinion of each as tabulated below :

Name of Wheat.	Milling Qualities.
1. Jones' Winter Fife -	Worthy of further trial. I think well of it.
2. American Bronze -	Well thought of.
3. Early White Leader -	Worthless.
4. Pride of Genesee -	Fair milling qualities.
5. Oatka Chief - -	Worthy of further test.
6. Long Amber - - -	Reasonably good.
7. Jones' Bearded - - -	I do not think very well of it.
8. Pride - - - -	Fair milling qualities.
9. Bearded Winter Fife -	Worthy of special at- tention. I think highly of this wheat.
10. Early Arcadian -	One of the best.
11. Pedigreed Early Genesee Giant - - - -	Fine wheat.
12. Diamond Grit -	Not to be recommended.
13. White Golden Cross -	Good milling wheat.
14. Lancaster Red - - -	Best milling wheat.
15. Democrat - - - -	Think well of it.
16. Gold Coin - - - -	Test it further.
17. Dawson's Golden Chaff -	Good milling wheat.

2. Test of Fertilizers.

This year, as heretofore, fertilizers had no appreciable effect on the yield of grain or straw—the kind of fertilizer used and the manner of applying it, were the same as in years previous, for which see Bulletin 57. The results of the year are of so little value when taken alone that it is thought best not to publish them herein.

3. Descriptions of the Varieties of Wheat.

BY H. GARMAN, ENTOMOLOGIST AND BOTANIST.

The following descriptions of the seventeen varieties tested on the Experiment farm in 1897 are drawn solely from samples of ripened wheat taken from the plots. The names applied are furnished me by those in charge of the experiments. It is not improbable, considering the confusion that exists in the names of varieties, that in at least one instance (Nos. 4 and 8) the same variety is described under two different names. The differences and resemblances will, however, be sufficiently evident from the descriptions and figures.

The majority of the varieties can be easily recognized. The most evident character is the presence or absence of a beard, but after separating the ten bearded varieties from the seven beardless ones, the varieties comprised under the two heads may be readily subdivided by the color of the spike or head, some being of an umber-brown color, while others are of the usual pale yellow. The color of the stem or culm is also in some cases a ready means of recognition, as is also the shape and average size of the spike. A very important character, which may easily be overlooked, sometimes separates varieties which are in other respects almost or quite the same. It is the presence of a very fine, whitish, velvety down or pubescence on the outer scales which cover the grain. Its presence can be best recognized by holding a spike up to the light and turning it from side to side. No. 1 of the beardless varieties is thus pubescent, while numbers 4, 8 and 9 of the bearded wheats possess the same character.

These are the characters upon which chief dependence is placed in the following synopsis and descriptions. It

is to be regretted that the character of the blade and the average number of heads produced from a stool by each variety cannot be included. The observations on red rust were made in the field, June 29. A few words of explanation may be added to make the descriptions more readily understood. A head or spike of wheat is made up of a central axis, which is a continuation of the stem, upon which are borne the flowers from which the seed is developed. The flowers grow in regularly placed clusters, one above another, in two rows, placed on opposite sides of the axis. A single complete cluster of flowers (See plate I. fig. 1.) is fan-shaped, the individual flowers diverging somewhat from each other. If the clusters forming a row are far apart, and lie close against the axis, the spike, as a whole is flattened. But when the clusters are crowded they overlap each other and stand out from the axis, in which case the two diameters may be alike, or what is commonly the shorter, may exceed the other. In several varieties the crowding of the clusters becomes gradually greater towards the upper end of the spike so that this extremity becomes oddly widened, as appears in No. 10, plate 3. Two or three lower clusters on each head of wheat are imperfect, consisting of a single flower which does not produce a seed. But farther up the number of flowers in a cluster is increased to five (See fig. 1, plate I.), although only three or four of the outermost produce seeds. In the mature head of wheat the two outer flowers of a complete cluster consist each of three scales and a seed. The outermost scale (empty glume) on each is provided with a small ridge or keel on the outside, and is in the beardless varieties rather blunt at the tip, while in the bearded wheats the tip is formed by a short bristle (Plate I. fig. 2). The scales next to these empty glumes are, in bearded wheats, provided with long bristles which constitute the

beard (Plate I. fig. 2, B), but in the beardless wheats these bristles are represented by a short claw-like process below, which increases toward the upper end of the spike to a length of a half inch or more. The bristle-bearing glumes enclose the seed on the outside, while the inner side of every seed is enclosed by a somewhat boat-shaped scale known as a palet (Plate I. fig. 2, C). The three scales enclosing one of the outer seeds of a cluster are shown separated from each other in figure 2, plate I.

Synopsis of the 17 Varieties.

Good descriptions and synopses of the varieties of wheat, based upon a critical examination and comparison, are greatly needed, and it is to be hoped that some one having access to all the literature will soon undertake the task of sifting out the spurious varieties and putting those well established in such shape that they can be recognized. The present synopsis covers a small part of the field, and is offered only as a convenience in connection with the descriptions which follow it.

Begin with paragraph 1. As long as your sample of wheat agrees with the characters given, go ahead taking one number after another until you reach a paragraph with dotted line leading out to the name of the variety.

But whenever you find a paragraph with which your wheat does not agree the number in parenthesis directs you down the line to a paragraph where your wheat will agree. Suppose you have in your hand a bearded wheat with spike tapering at upper end, the glumes downy (pubescent) and the seeds white: Read paragraph 1. You find your wheat does not agree. The number 14 in parenthesis says, "go down the line to paragraph 14 where your wheat does agree." Now read the next paragraph, 15. You will find your wheat does not agree and you are again sent down the line, to 18. Then read

19, with which it agrees, and you read the next paragraph, 20, to find yourself directed to 21, where the quest terminates, the dotted line leading to the name "Bearded winter fife."

1. (14) Beardless.
2. (7) Spike enlarging at upper end (nearly even in No. 3.)
3. (4) Spike and stem yellow - - - - - Early white leader (No. 3).
4. (3) Spike brown.
5. (6) Stem yellow - - - - - Early Arcadian (No. 10).
6. (5) Stem purplish - - - - - Gold coin (No. 16).
7. (2) Spike tapering at upper end.
8. (9) Spike pubescent - Jones's winter fife (No. 1).
9. (8) Spike not pubescent.
10. (13) Spike and stem yellow.
11. (12) Seeds red - - - - - American bronze (No. 2).
12. (11) Seeds white - - - - - Long amber (No. 6).
13. (10) Spike brown, stem yellow - - - - - Dawson's golden chaff (No. 17).
14. (1) Bearded.
15. (18) Spike enlarged at upper end.
16. (17) Spike and stem yellow with reddish tinge. . . .
 Oatka chief and Jones's bearded (Nos. 5 and 7).
17. (16) Spike umber-brown, stem purplish - - - - -
 - - - - - Pedigreed giant and White golden cross
 - - - - - (Nos. 11 and 13).
18. (15) Spike tapering at upper extremity.
19. (22) Spike pubescent.
20. (21) Seeds red - - - - -
 - - - - - Pride of Genesee and Pride (Nos. 4 and 8).
21. (20) Seeds white - - - - - Bearded winter fife (No. 9).
22. (19) Spike not pubescent.
23. (26) Seeds red.

24. (25) Spike yellow, stem purplish - - -
 - - - Diamond grit (No. 12).
 25. (24) Spike brown, stem purplish - - -
 - - - Lancaster red (No. 14).
 26. (23) Seeds white, spike and stem yellow - - -
 - - - Democrat (No. 15).
-

No. 1. Jones's Winter Fife.

Beardless. Seeds white*. Spike long and slender, tapering slightly towards the upper end, flattened. Average length of four spikes, 5.125 inches; greater diameter, 0.5 inch; lesser diameter, 0.375. Glumes covered with a fine whitish, velvety pubescence. Empty glumes, with very short, blunt prominences at tips. Flowering glumes with claw-like tips, which become gradually longer towards the upper end of the spike, where a few become straight, sharp bristles about 0.25 inch long. Color of spike and stem, pale yellow. Average number of seeds from a spike, 86.75. Average weight of seeds from a spike, 3.2875 grams.

Rust on stem and blade frequent.

No. 2. American Bronze.

Beardless. Seeds red. Spike very long and slender, the spikelets separated so that the axis of the spike can sometimes be seen between them, flattened, tapering towards both extremities. Average length of four spikes, 5.3125 inches; greater diameter, 0.625 inch; lesser diameter, 0.375 inch. Glumes not pubescent. Empty outer glumes with short, rounded tips, the keels on their backs more decided than in many other varieties.

*The terms white and red are used in these descriptions as they are by millers and seedmen. Strictly speaking, the white wheats are pale ochraceous, while red wheats, so-called, are generally of a light leather color.

Flowering glumes, with claw-like tips, which increase in length towards the upper end of the spike, where a few become bristles one-half inch long. Color of spike and stem, pale yellow. Average number of seeds from one spike, 56.5. Average weight of seeds from one spike, 2.4 grams.

This wheat bears a general resemblance to No. 1, but the spike is more slender and the glumes without pubescence. Rust frequent.

No. 3. Early White Leader.

Beardless. Seeds white. Spike long and slender, the spikelets becoming crowded at the upper end of the spike so that it is a little widened at the extremity. Average length of four spikes, 5.34 inches; greater diameter, 0.50 inch; lesser diameter at middle of spike, 0.37 inch, but widened to 0.50 inch at tip. Glumes not pubescent. Empty glumes with short, rounded tips. Flowering glumes with claw-like tips, a few at the extremity of the spike with the tips produced into short spines, as much as one-fourth inch long. Color of spike and stem pale yellow. Average number of seeds from one spike, 74.25. Average weight of seeds from one spike, 2.85 grams.

Closely resembles No. 2, but readily distinguished by its white seed and the slight enlargement of the tip of the spike. Rust very abundant.

No. 4. Pride of Genesee.

Heavily bearded. Seeds red. Spike long and slender, tapering to the upper end, flattened. Average length of four spikes, 5.81 inches; greater diameter, 0.62 inch; lesser diameter, 0.37 inch. Glumes pubescent. Empty glumes with a bristle at the tip varying from 0.25 to 0.62 inch in length. Flowering glumes with long bristles varying

from 1 inch long at the base to more than 4 inches on the upper half of the spike. Color of spike and stem pale yellow. Average number of seeds from one spike, 79.5. Average weight of seeds from one spike, 2.95 grams.

A very striking variety, to be recognized by its shaggy beard and pubescent glumes. Rust frequent.

No. 5. Oatka Chief.

Bearded. Seeds white. Spike short and thick, widened in one direction at the tip. Average length of four spikes, 4.44 inches; greater diameter, 0.50; lesser diameter, 0.37 inch, increasing to 0.50 inch at the tip. Glumes not pubescent. Empty glumes tipped with a short but decided bristle which reaches a length of about 0.25 inch at the upper end of the spike. Flowering glumes tipped with long bristles varying from 1.25 to 3.25 inches in length. General color of spike and stem yellow, but both with an evident reddish cast. Average number of seeds from a spike, 74. Average weight of seeds from one spike, 2.67 grams.

Rust rare.

No. 6. Long Amber.

Beardless. Seeds white. Spike long and slender, tapering to upper end, flattened. Average length of four spikes, 5.53 inches; greater diameter, 0.50; lesser diameter, 0.37 inch. Glumes not pubescent. Empty glumes with short rather blunt tips. Flowering glumes with short bristles, varying from 0.12 to 0.50 inch long, the latter being situated at the apex of the spike. Color of spike and stem pale yellow. Average number of seeds from a spike, 59.25. Average weight of seeds from one spike, 2.32 grams.

The spike of this wheat resembles No. 2 very closely and might be considered identical were it not for the color of the seeds. Rust frequent.

No. 7. Jones's Bearded.

Bearded. Seeds white, but darker in tint than some other varieties (Nos. 10 and 17, for example). Spike moderately stout, not flattened, enlarging at the upper end. Average length of four spikes, 4.53 inches; both diameters, 0.50 inch, but one of them enlarging to 0.62 inch near the tip. Glumes without pubescence. Empty glumes with tips produced into short bristles about 0.25 inch long. Flowering glumes armed with bristles from 1 to 3.87 inches long. General color of spike and stem yellow, but both glumes and stem with a reddish tinge. Average number of seeds from a spike, 85.75. Average weight of seeds from a spike, 3.04 grams.

This variety bears a close resemblance to Oatka chief (No. 5), having the same reddish tinge and the spike of the same general shape. About the only differences apparent in the samples before me are the greater coarseness of No. 7 and the slightly greater average size. The seed of No. 7 is a little less plump and averages darker in color. All these differences might, however, be due to differences in the soil in which the two samples grew or to differences in seed planted. The wheats grown under these two numbers are certainly very closely related, if they are not one and the same. Rust rare.

No. 8. Pride.

Heavily bearded. Seeds red. Spike long and slender, tapering gradually towards the tip, flattened. Average length of four spikes, 5.06 inches; greater diameter, 0.62 inch; lesser diameter, 0.37 inch. Glumes pubescent. Empty glumes with bristles ranging in length from 0.25 to 0.62 inch. Flowering glumes with bristles ranging from 1 to 3.25 inches in length. Color of spike and stem pale yellow. Average number of seeds from a spike, 70.5.

Average weight of seeds from one spike 2.65 grams.

Probably identical with No. 4. I can see no difference of importance between the two samples. Rust abundant.

No. 9. Bearded Winter Fife.

Bearded. Seeds white and plump. Spike rather small and slender, flattened, tapering to the upper extremity. Average length of four spikes, 4.80 inches; greater diameter, 0.50 inch; lesser diameter, 0.37 inch. Glumes finely pubescent. Empty outer glumes provided with short bristles ranging from about 0.12 to 0.37 inch in length, the longest being, as is common, at the upper end of the spike. Flowering glumes bearing bristles which gradually increase in length from the base to the upper end, ranging from 1 to 3.25 inches long. Color of spike and stem pale yellow. Average number of seeds from a spike, 61. Average weight of seeds from one spike, 2.57 grams.

Rust frequent.

No. 10. Early Arcadian.

Beardless. Seeds white, rather short, plump. Spike short, thick, enlarging towards the upper extremity. Average length of four spikes, 3.37 inches; greater diameter, 0.50 inch; lesser diameter, 0.37 inch at base, but increasing to 0.75 inch at upper end. Glumes not pubescent. Empty outer glumes with short, blunt tips. Flowering glumes with claw-like tips, these increasing in length towards the upper extremity of the spike, where a few are nearly 0.50 inch in length. Color of spike umber-brown, this color being confined, however, to the exposed parts of the glumes, the covered portions being pale yellow. Stem pale yellow. Average number of seeds from a spike, 65. Average weight of seeds from a spike, 2.5 grams.

Very distinct from any of those described above in the short, thick, club-like spikes, with brown glumes. Rust rare.

No. 11. Pedigreed Giant.

Strongly bearded, especially on the upper fourth of the spike. Seeds white. Spike short, thick, enlarging to the upper extremity, not flattened. Average length of four spikes, 3.18 inches; both diameters, 0.37 inch at base, one of them increasing to 0.62 inch at tip. Glumes not pubescent. Empty glumes with claw-like tips on the basal portion of the spike, these increasing in length towards the upper end, where some are nearly 0.25 inch in length. Flowering glumes with long bristles, varying from 0.37 inch in length at the base to 4 inches in length at the upper extremity of the spike. Color of spike umber-brown, of stem obscure lilac. Average number of seeds from a spike, 72.5. Average weight of seeds from a spike, 3.2 grams.

No rust.

No. 12. Diamond Grit.

Heavily bearded. Seeds red. Spike rather slight and short, tapering to the upper extremity. Average length of four spikes, 4.19 inches; both diameters about 0.37 inch. Glumes not pubescent. Empty outer glumes with a short acute bristle at tip. Flowering glumes varying in length from 1.25 inch to 3.50 inches. Color of spike pale yellow, of stem purplish. Average number of seeds from a spike, 60. Average weight of seeds from a spike, 2.2 grams.

Rust frequent.

No. 13. White Golden Cross.

Bearded. Seeds white. Spike short and thick, enlarging towards the upper extremity. Average length

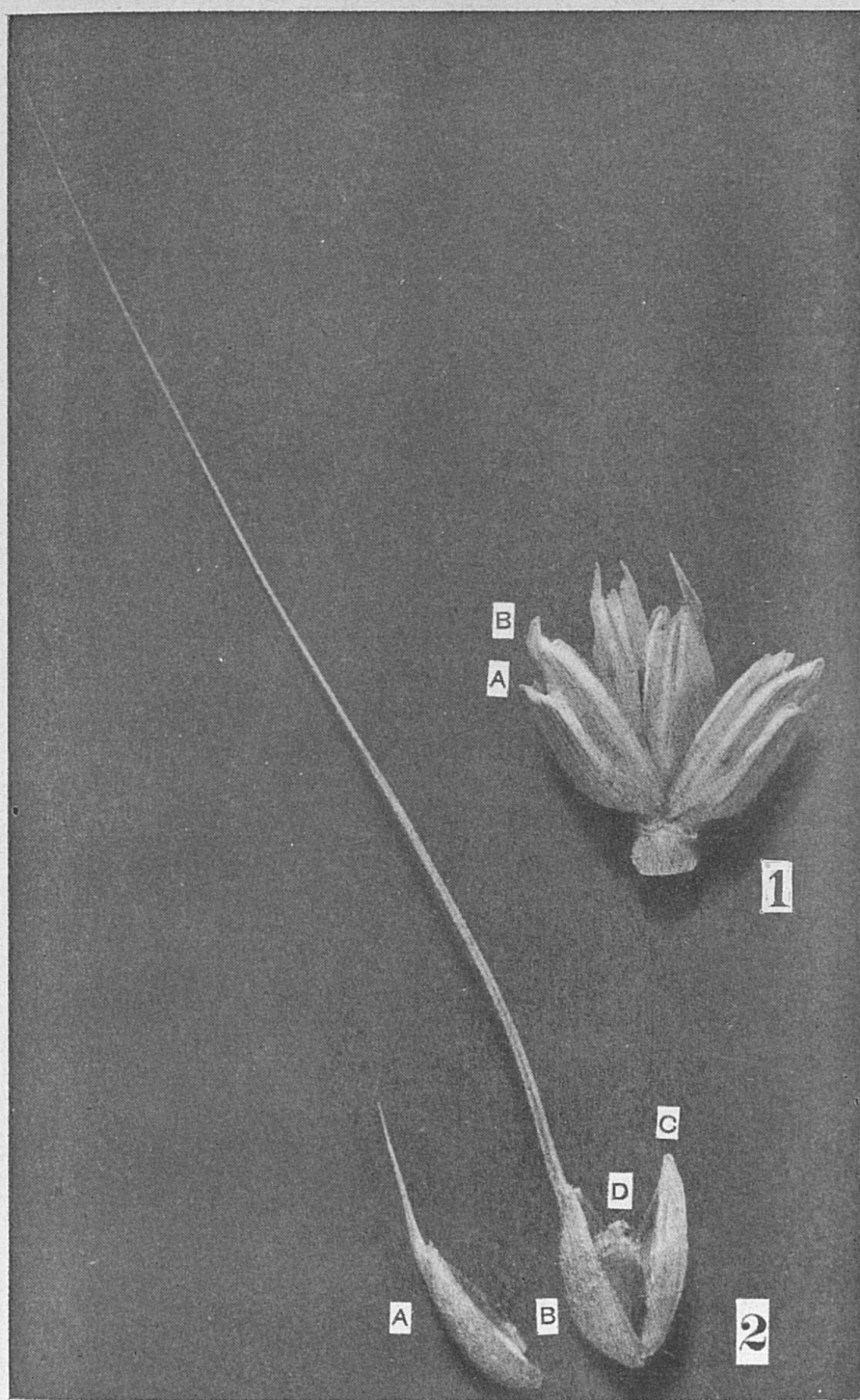


PLATE I.

FIG. 1. A complete flower cluster or spikelet of a beardless wheat (American bronze). A, empty outer glume; B, flowering glume. FIG. 2. A single flower of a bearded wheat (Pride of Genesee) with the parts separated. A, empty outer glume; B, bristle-bearing flowering glume; C, palea; D, seed.

Enlarged a little more than two diameters. Photographed by H. Garman.

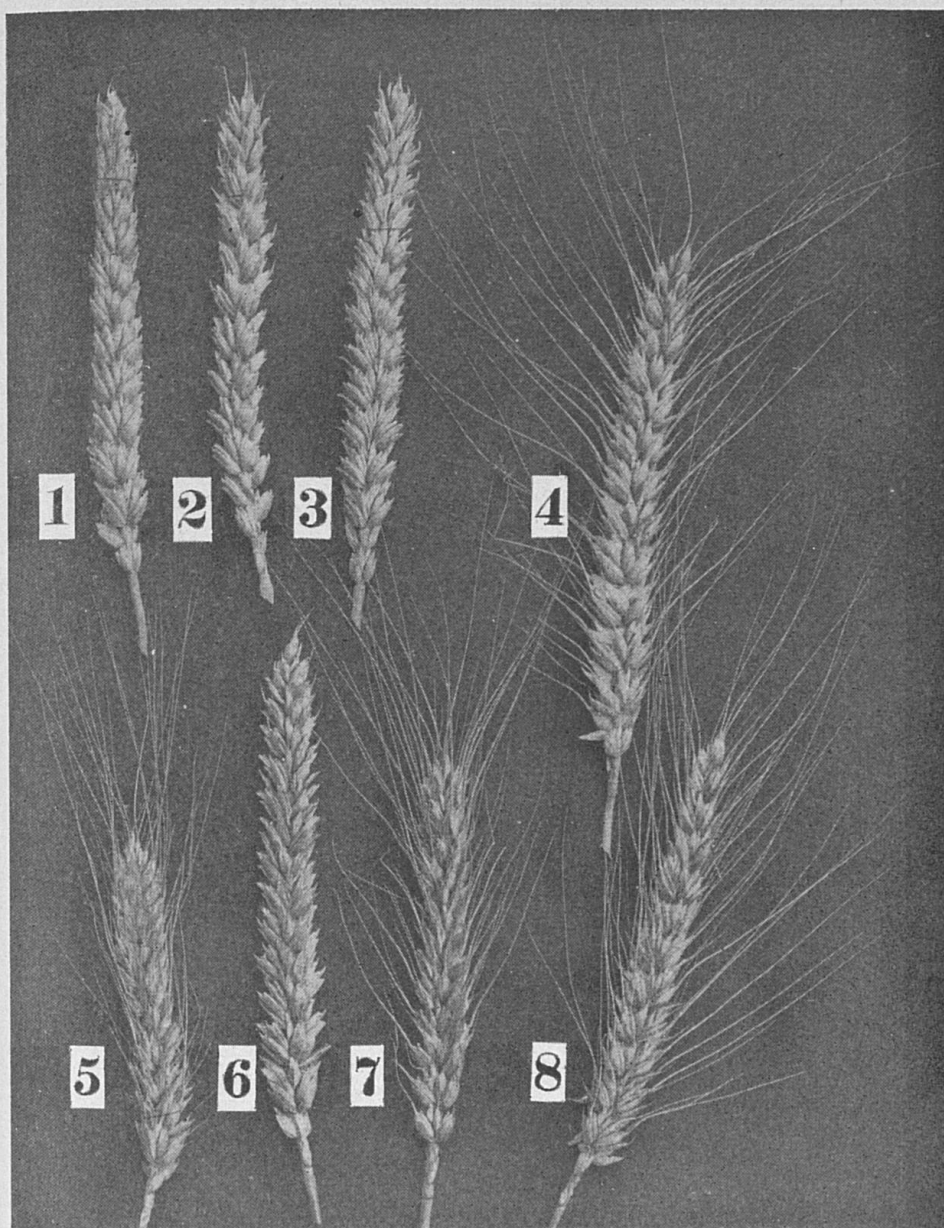


PLATE II.

1, Jones's winter fife; 2, American bronze; 3, Early white leader; 4, Pride of Genesee; 5, Oatka chief; 6, Long amber; 7, Jones's bearded; 8, Pride. Reduced to about one-half natural size. Photographed by H. Garman.

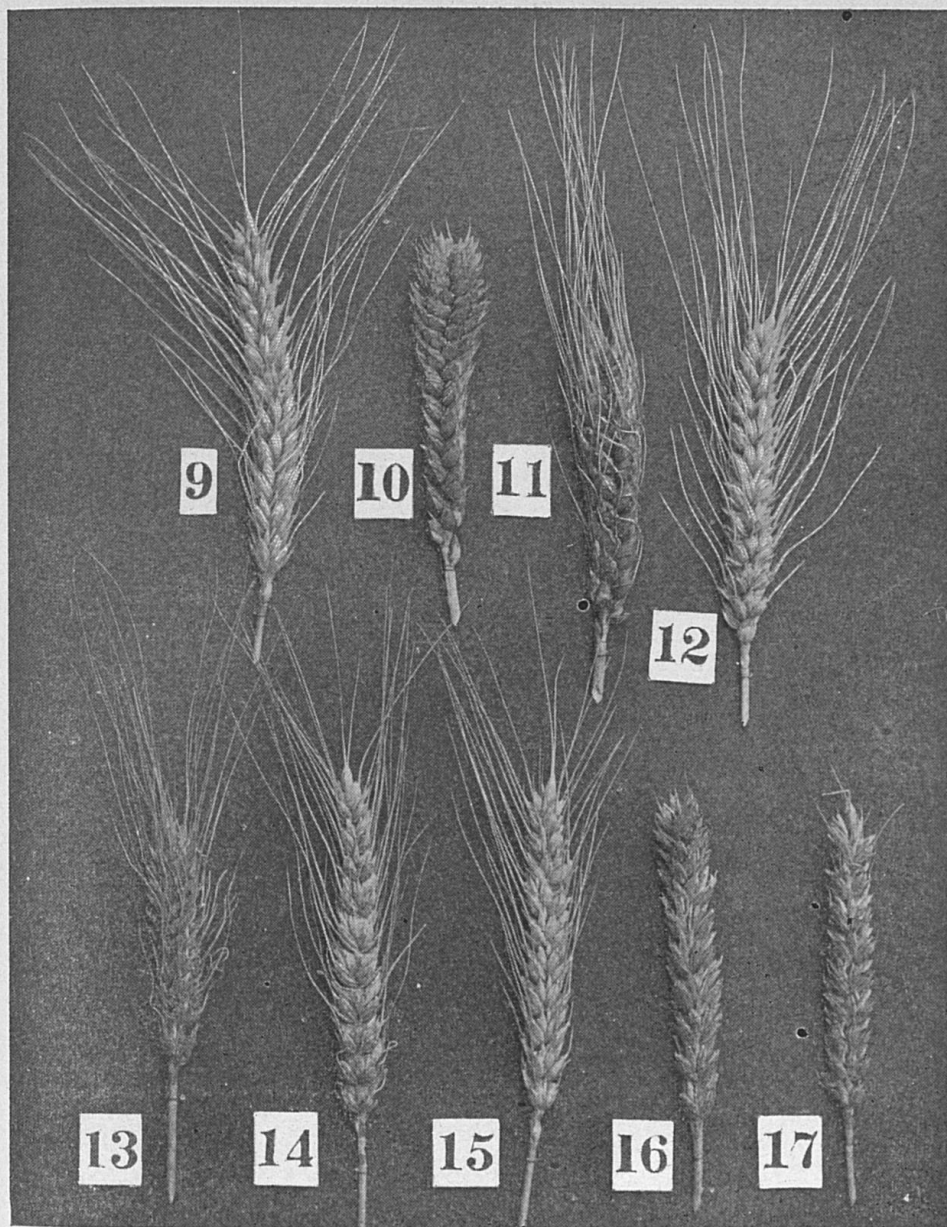


PLATE III.

9, Bearded winter fife; 10, Early arcadian; 11, Pedigreed giant; 12, Diamond grit; 13, White golden cross; 14, Lancaster red; 15, Democrat; 16, Gold coin; 17, Dawson's golden chaff. Reduced to about one-half natural size. Photographed by H. Garman.

of four spikes, 3.19 inches ; greater diameter, 0.50 inch ; lesser diameter, 0.37 inch at base, increasing to 0.62 inch at upper extremity. Glumes not pubescent. Empty outer glumes with short, acute spine at tip. Flowering glumes tipped with bristles, about one inch long at base and as much as four inches in length at the upper extremity of the spike. Color of spike umber-brown, of stem purplish. Average number of seeds from a spike, 63.5. Average weight of seeds from a spike, 2.85 grams.

Closely resembles Number 11 in every respect, but in the sample before me the length of spike averaging less. No rust.

No. 14. Lancaster Red.

Bearded. Seeds red. Spike small, slender, somewhat flattened, tapering to upper end. Average length of four spikes, 4.34 inches ; greater diameter, 0.50 inch ; lesser diameter, 0.37 inch. Glumes not pubescent. Spines on outer glumes short, straight, acute, becoming as much as 0.50 inch in length towards the apex of the spike. Bristles on flowering glumes ranging from 2.37 to 3.62 inches in length. Color of spike brown, of stem purplish. Average number of seeds from a spike, 49.25. Average weight of seeds from a spike, 1.95 gram.

The spike of this variety is very slight and small and tapers quite decidedly towards the tip. The glumes show a disposition to separate in the ripened head, so that the seed becomes visible. In the sample examined by me I find some spikes clothed with fine pubescence, while in every other respect they resemble closely the other spikes. It seems hardly probable that the same variety should vary to this extent, but it may be that the wheat from which the sample was grown was mixed. No rust.

No. 15. *Democrat.*

Strongly bearded. Seeds white. Spike rather slender, of medium length, flattened, tapering decidedly to the upper extremity. Average length of four spikes, 4.43 inches. Glumes without pubescence. The empty outer glumes with short, claw-like tips at the base of the spike and at its upper extremity with bristles nearly 0.25 inch in length. Flowering glumes with bristles ranging in length from one to three inches. Color of spike and stem pale yellow. Average number of seeds from spike, 15.75. Average weight of seeds from spike, 2 grams.

No rust.

No. 16. *Gold Coin.*

Beardless. Seeds white. Spike of medium size, enlarging a little to the upper extremity. Average length of four spikes, 4.06 inches; greater diameter, 0.50 inch; lesser diameter, 0.37 inch below, increasing a little above. Glumes not pubescent. Empty outer glumes everywhere with rather short, blunt tips. Flowering glumes with claw-like tips at base of spike which become gradually longer upward until at the upper end of the spike a few reach a length of one-half inch. Color of spike umber-brown, of stem purplish. Average number of seeds from a spike, 60. Average weight of seeds from a spike, 2.44 grams.

Rust rare.

No. 17. *Dawson's Golden Chaff.*

Beardless. Seeds white and plump. Spike rather small and slender, scarcely flattened, tapering to the upper extremity. Average length of four spikes, 3.81 inches; both diameters about 0.37 inch. Glumes not pubescent. Empty outer glumes with very short, blunt tips. Flowering glumes at base of spike with claw-like tips and at its apex with bristles which may in a few

cases reach a length of 0.62 inch. Color of spike umber-brown, of the stem pale yellow. Average number of seeds from a spike 43.75. Average weight of seeds from one spike, 1.82 gram.

The seeds of this variety are exceptionally plump and light in color. No rust.

4. Hot Water and Bluestone Solutions as Remedies for Smut in Wheat.

BY H. GARMAN, ENTOMOLOGIST AND BOTANIST.

It should be more generally known than it is that bluestone, when used in very strong solutions, destroys the vitality of a portion of the seeds soaked in it. This effect of the solutions is not apparent except by comparison with untreated seed, and hence the diminished yield is not likely to be recognized on the farm as the result of treatment. While this loss should be avoided if possible, it is more than offset by the increase in yield due to the prevention of smut, and hence in spite of its defect bluestone is recommended everywhere as an effective means of saving wheat from smut.

The common practice is to make up a solution by dissolving six pounds of bluestone in four gallons of hot water, then pouring this into a barrel and adding enough water to make 20 gallons. The seed wheat is dipped in this in loose bags, care being taken that every seed is wetted, then the surplus solution is drained out by resting the bag for a brief time on sticks placed across the top of the barrel, and finally the wheat is poured out on a floor and dusted with air-slaked lime.

If the wheat is to be sprinkled it is poured in a heap on a barn floor and the solution is applied with a watering can, the wheat being raked about at the same time

until all is wetted, when it is dusted with lime as before and spread out to dry.

Careful comparative tests of bluestone solutions and of hot water as preventives of smut show that hot water is quite as effective in checking the disease and has the advantage of not injuring the sound seed. When treating seed with hot water it is well to be provided with the following: A good Fahrenheit thermometer. A large kettle in which water can be heated. Three barrels.

The water in the kettle is kept near the boiling point, and the supply in it must be replenished as fast as it is used. In the first barrel keep ordinary water, and the other two should be about two-thirds full of water kept at a temperature of 131 degrees Fahrenheit.

First put a bag of wheat in the barrel of cool water and leave it until all the seeds are moist. It may be left for half an hour, or longer, but ordinarily two or three minutes is sufficient. Drain out the surplus cold water, then immerse for a minute or two in the second barrel, containing warm water. The object of this is to warm the wheat so that it will not cool the water in the third barrel. When warm, plunge quickly in the third barrel and leave it fifteen minutes. If the temperature shows a disposition to fall below 131 degrees, add a little hot water from the kettle till it reaches the 131 mark again. It should never be allowed to fall below 130 degrees, nor to go above 134 degrees Fahrenheit. With a good supply of hot water at hand it is very easy to regulate the temperature in the barrel, much easier than would be supposed by one who has not tried it. At the end of fifteen minutes the wheat is removed from the water and spread out to dry. But it must never be spread out on a floor upon which smutted wheat has lain. The convenience, cleanliness and cheapness of this method of preventing smut will certainly commend it to farmers, and I have no doubt but that it will displace the use of bluestone in course of time.

KENTUCKY
AGRICULTURAL EXPERIMENT STATION
OF THE
STATE COLLEGE OF KENTUCKY.

BULLETIN NO. 70.

1. The Woolly Mullein.
 2. The Gape Disease of Poultry.
-

LEXINGTON, KENTUCKY.

DECEMBER, 1897.

KENTUCKY

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ADDRESS :

KENTUCKY AGRICULTURAL EXPERIMENT STATION,
LEXINGTON, KY.

BULLETIN No. 70.

1. THE WOOLLY MULLEIN (*Verbascum phlomoides*) IN KENTUCKY.

BY H. GARMAN, ENTOMOLOGIST AND BOTANIST.

In 1896 the Assistant Secretary of the United States Department of Agriculture wrote to the Kentucky Station calling attention to the presence of the woolly mullein in this State and suggesting the advisability of undertaking its extermination. Previous (August, 1895) to that time Dr. J. N. Rose of the Department had looked over the region in which the mullein was established and had prepared a preliminary map of its distribution, as it was known to him, which was kindly placed in our hands. Dr. Rose found the mullein abundant at Dickey's Mills on the north side of Nolin River in Grayson County. On the south side of the river in Edmonson County he found some plants along the road leading toward Mammoth Cave for a distance of perhaps a quarter of a mile from the ford. The mullein was scattered along the roads on the north side of the river in every direction for a distance of a half mile to three-fourths of a mile from the ferry. Two miles from the river on the Grayson Springs Station road Dr. Rose found a few plants in a barnyard and two and a half miles from the river on the same road he found ten plants in a barnyard and one in a pasture opposite.

In July, 1896, the writer visited Dickey's Mills for the purpose of looking into the question as to whether or not it was feasible and desirable to attempt to destroy the

plants in the infested area and thus check the further extension of the weed in this country. The plants that had been mapped by Dr. Rose were quickly destroyed by employing several men for few a days, but it was observed that a good many plants grew close along the banks of the river on ground that was flooded in spring, which suggested the possibility that the seeds had been sown by the water along the lower part of the stream, below Dickey's Mills. Examination proved the surmise to be well founded, and six miles below the ford (by river) a large number of plants were found and destroyed. The distribution of these plants left no doubt as to the agency of the river in sowing the seeds, for the plants often grew thickly at the edge of the stream when they could not be found elsewhere in the immediate neighborhood. The banks of Nolin River were now examined from the point at which these plants were found down to its junction with Green River, and subsequently Green River was examined at Brownsville and at the mouth of Nolin, but no other plants were discovered.

In July, 1897, I returned to Dickey's Mills where I found the mullein still in considerable numbers, the seedlings of the previous year being now conspicuous, and thence traveled by conveyance across country to Priceville in Hart County, where a few plants had been observed the year previous by one of the men engaged to help me. About midway between the two places, eight miles from Dickey's Mills, a few plants were found along the road, but none were found at Priceville. From Priceville I traveled northwest to Millerstown on Nolin River, at the extreme eastern end of Grayson County. About three miles south of Millerstown in Hart County, the mullein again appeared, becoming more and more abundant as I approached Nolin River, becoming finally on the banks of the stream more common than I had seen it elsewhere. It was apparent here, as at Dickey's Mills, that the river was the most active agent in distributing

the plant. In places the woolly mullein grew about as thickly as it could stand at the immediate edge of the stream, and extended in a sort of fringe along its banks. From Millerstown I traveled up Nolin River to White Mills in Hardin County, finding the mullein all along the route until I reached the latter point, when it disappeared. Later in the season the banks of Nolin River were explored at Nolin Station on the Louisville and Nashville railroad, and the stream was followed down to White Mills, but the plant was not found on these upper waters until White Mills was reached. The region about Elizabethtown has been given only a cursory examination while passing through, and it is not improbable that the weed will be found on the small branch of Nolin which originates near that place.

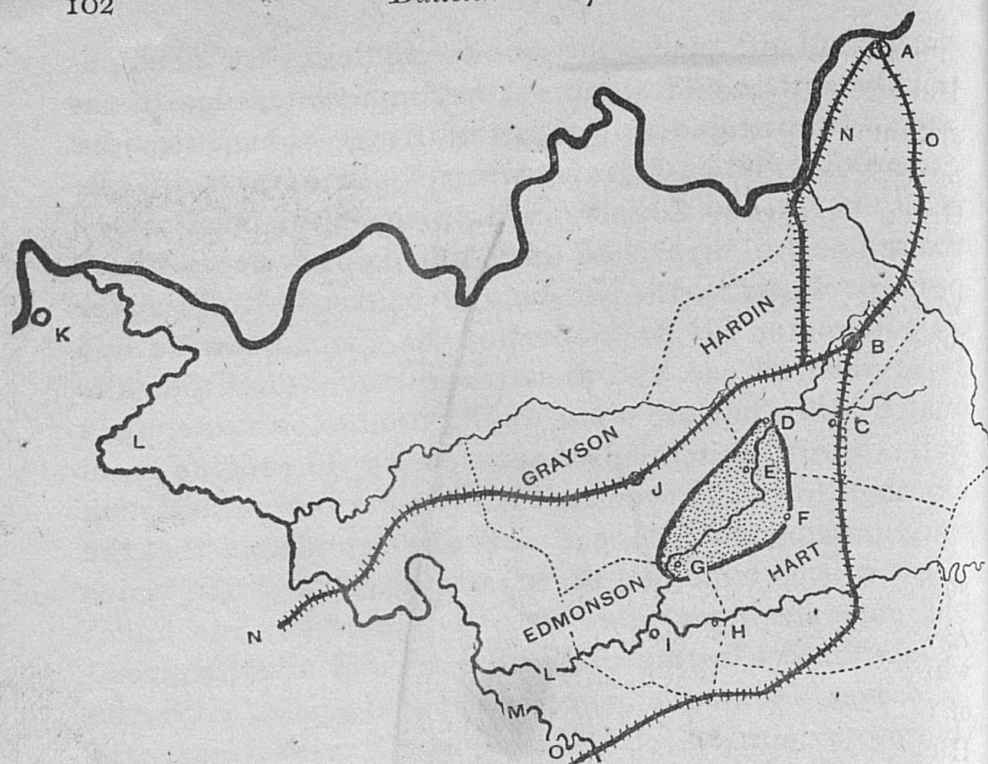
As known to me the mullein is now unevenly scattered over an area of not less than 50 square miles, including a portion of Edmonson, Grayson, Hart and Hardin counties, as indicated by the dotted area of the accompanying sketch. The infested region begins about 50 miles southwest of Louisville. It was, apparently, introduced originally somewhere on the headwaters of Nolin River, possibly at White Mills, possibly at Elizabethtown. This section is devoted to wheat growing, and numerous grist mills are located along the stream. Hence it is very probable that the mullein was brought here among wheat or other seeds imported from Europe. Including the windings of Nolin River the weed is distributed along a course perhaps 55 or 60 miles in length, not uniformly, but scattered, and abundant only where the conditions are favorable for the deposit of seeds by the water. The distance in a direct course from the lowest point on the river where the mullein has been found to White Mills is about 25 miles. Wherever the weed is abundant on the river it has spread for a distance of from 1 to 3 miles along roads leading into the surrounding country.

plants in the infested area and thus check the further extension of the weed in this country. The plants that had been mapped by Dr. Rose were quickly destroyed by employing several men for few a days, but it was observed that a good many plants grew close along the banks of the river on ground that was flooded in spring, which suggested the possibility that the seeds had been sown by the water along the lower part of the stream, below Dickey's Mills. Examination proved the surmise to be well founded, and six miles below the ford (by river) a large number of plants were found and destroyed. The distribution of these plants left no doubt as to the agency of the river in sowing the seeds, for the plants often grew thickly at the edge of the stream when they could not be found elsewhere in the immediate neighborhood. The banks of Nolin River were now examined from the point at which these plants were found down to its junction with Green River, and subsequently Green River was examined at Brownsville and at the mouth of Nolin, but no other plants were discovered.

In July, 1897, I returned to Dickey's Mills where I found the mullein still in considerable numbers, the seedlings of the previous year being now conspicuous, and thence traveled by conveyance across country to Priceville in Hart County, where a few plants had been observed the year previous by one of the men engaged to help me. About midway between the two places, eight miles from Dickey's Mills, a few plants were found along the road, but none were found at Priceville. From Priceville I traveled northwest to Millerstown on Nolin River, at the extreme eastern end of Grayson County. About three miles south of Millerstown in Hart County, the mullein again appeared, becoming more and more abundant as I approached Nolin River, becoming finally on the banks of the stream more common than I had seen it elsewhere. It was apparent here, as at Dickey's Mills, that the river was the most active agent in distributing

the plant. In places the woolly mullein grew about as thickly as it could stand at the immediate edge of the stream, and extended in a sort of fringe along its banks. From Millerstown I traveled up Nolin River to White Mills in Hardin County, finding the mullein all along the route until I reached the latter point, when it disappeared. Later in the season the banks of Nolin River were explored at Nolin Station on the Louisville and Nashville railroad, and the stream was followed down to White Mills, but the plant was not found on these upper waters until White Mills was reached. The region about Elizabethtown has been given only a cursory examination while passing through, and it is not improbable that the weed will be found on the small branch of Nolin which originates near that place.

As known to me the mullein is now unevenly scattered over an area of not less than 50 square miles, including a portion of Edmonson, Grayson, Hart and Hardin counties, as indicated by the dotted area of the accompanying sketch. The infested region begins about 50 miles southwest of Louisville. It was, apparently, introduced originally somewhere on the headwaters of Nolin River, possibly at White Mills, possibly at Elizabethtown. This section is devoted to wheat growing, and numerous grist mills are located along the stream. Hence it is very probable that the mullein was brought here among wheat or other seeds imported from Europe. Including the windings of Nolin River the weed is distributed along a course perhaps 55 or 60 miles in length, not uniformly, but scattered, and abundant only where the conditions are favorable for the deposit of seeds by the water. The distance in a direct course from the lowest point on the river where the mullein has been found to White Mills is about 25 miles. Wherever the weed is abundant on the river it has spread for a distance of from 1 to 3 miles along roads leading into the surrounding country.



A, Louisville; B, Elizabethtown; C, Nolin Station; D, White Mills; E, Millerstown; F, Priceville; G, Dickey's Mills; H, Mammoth Cave; I, Brownsville; J, Leitchfield; K, Henderson; L, L, Green River; M, Barren River; N, N, Kentucky branch Illinois Central R. R.; O, O. Louisville & Nashville R. R. The dotted area bounded by black line showing region known to be occupied by woolly mullein.

Its Dissemination.

It is assumed that the woolly mullein was brought to Kentucky among seeds, or else with imported goods of some kind among packing. And if carried from one country to another by this means it is not improbable that it has been scattered in the same way to some extent since its introduction. Yet from what I have seen of it I am disposed to believe that its seeds are not commonly carried from place to place with other seeds, and that since its introduction it has been disseminated chiefly, if not entirely, by other agencies. Undoubtedly it is being gradually carried down Nolin River, and if not checked will ultimately reach Green River and, later, the Ohio. Green River has, as already stated, been ex-

amined at Brownsville and at the mouth of Nolin. During the past summer it was carefully examined also at South Carrollton in Muhlenburg County, but thus far no evidence of the occurrence of woolly mullein along Green River has been forthcoming.

The question as to the length of time seeds of the woolly mullein will bear immersion in water is an important one in this connection, and the Station is indebted to Dr. F. V. Coville, Chief of the Division of Botany at the U. S. Department of Agriculture, who kindly tested seeds furnished him. Under date June 5, 1897, he wrote me:

"The seeds of *Verbascum phlomoides* you sent us some time ago for germination test showed an average of 73 per cent., after floating seven days in a bowl of water, while on the fourteenth day they showed a germination of 69 per cent., according to experiments made by Mr. Hicks. Practically, therefore, these seeds would not lose their vitality through any soaking with water that they are likely to get while being carried down a stream."

Supposing the distance from Dickey's Mills on Nolin River to the mouth of Green River to be 200 miles, including the windings of the stream, and that the water at flood time flows at the rate of three miles per hour, in only $2\frac{3}{4}$ days mullein seeds might be carried to the mouth of Green River; and it is perhaps too much to hope in view of these considerations that the mullein is not already established in places along Green River.

Away from Nolin River the mullein is distributed very largely along roads, a fact which suggests the agents by which it is carried. The plants with ripened seeds remain standing for a long period, sometimes in sheltered places all winter, and I have sometimes taken seeds from old plants that had flowered twelve months previous. Sheep and hogs roaming among such plants no doubt sometimes shake the seeds from the open capsules, and

these falling upon their backs and clinging there would often be carried some distance before being again detached. In mud on the feet of stock and on the wheels of wagons it is probable the seeds are also sometimes conveyed from one point to another. But the seeds are not provided with special means for clinging to the coats of animals, and have no special equipment for their dissemination otherwise, hence except by water their spread is rather slow, and were it not for the part taken by the river it would be a long time in all probability before the species became widely scattered in this country.

Its History in Kentucky.

Its history in Kentucky corroborates this view of the matter. In the letter above mentioned, from the Assistant Secretary of Agriculture, it was stated that the first plant received at the Department was sent in about eight years previous, which would make the date of its discovery about 1888. At that time it had been carried down Nolin River nearly to the lowest point on the stream at which it now occurs, for the plant then sent to Washington was obtained at Dickey's Mills. I am informed, however, by Mr. R. W. Horn, who resides at Dickey's Mills, that the plants were very scarce there at that time and that he had difficulty in getting specimens to send to Mr. C. F. Very of New Albany, Indiana, to whom belongs the credit of first noticing the plant.

How long the plant has been in the State can only be a matter of conjecture. Assuming that the mullein has been carried by Nolin River only six miles below Dickey's Mills since 1888, and that it was carried from the headwaters of the stream at the same rate, it must have taken at least fifty years to reach Dickey's Mills; for the distance from this place to White Mills in a direct course is 25 miles, and the length of the bed of the river between the two places is fully twice as great. That a plant of this sort should be present for so long a time without

being detected need not surprise us greatly when we remember that the region in which the mullein is established is not thickly peopled and that many of those living there have never observed that two kinds of mullein are present.

The Woolly Mullein in Europe.

I am indebted to Mr. Dewey of the Division of Botany, U. S. Department of Agriculture, for references to the works of a number of European botanists who have written on the woolly mullein. It seems that the plant is widely distributed through Continental Europe. It is recorded by one or another from Spain, France, Denmark, Sweden, Germany, Austria, Italy, Greece, Russia and most of the other smaller countries. Nothing very definite can be gathered from these writers, however, with reference to its character as a weed, but they agree very well as to the situations in which it is generally found, noting it as growing at the edges of fields and on neglected land, in dry and often sandy or rocky places.

The Woolly Mullein as a Weed in Kentucky.

The woolly mullein is not restricted to dry and barren soil in Kentucky, but grows wherever it gets a foothold, excepting in thick woods. It flourishes on the richest land along Nolin River. As often happens with introduced plants and insects it seems to have developed a more aggressive disposition here than in its native land, *but it does not thrive in cultivated fields when these are properly cared for*, and hence is not to be feared like crab grass, for example, which persists in spite of hoe and plow. It is chiefly as a useless frequenter of roadsides, pastures and meadows, where it crowds out useful plants, that it is objectionable, being in this respect much like its cousins the common mullein and moth mullein, and I agree with Mr. Dewey when he writes in a letter addressed to me some time ago: "If allowed to spread unmolested the woolly mullein would probably become no

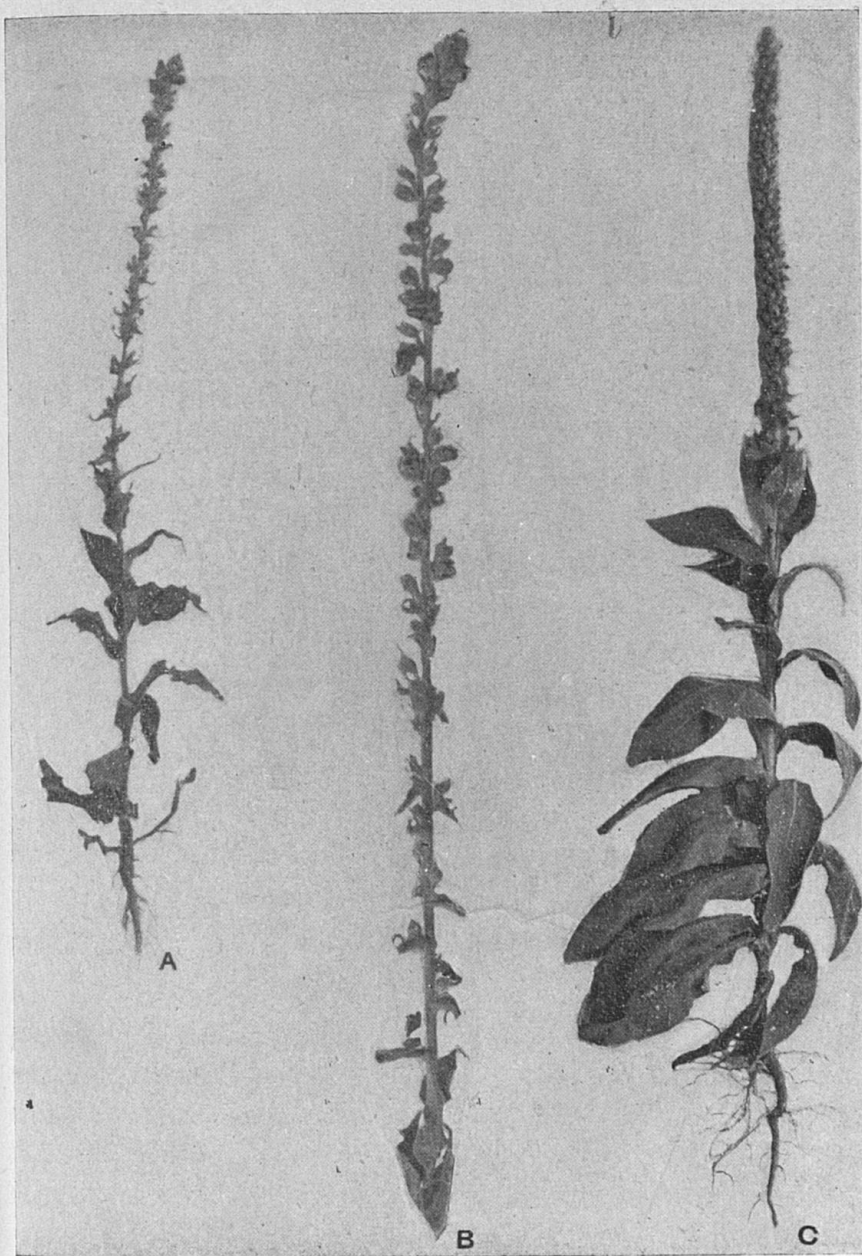
worse as a weed than the black mullein or the moth mullein, but there appear to be abundant indications that it might be fully as bad, and a good work will certainly be accomplished if a weed as bad as one of these is prevented from becoming established in this country."

We have already addressed a circular to the farmers living along Nolin River requesting their aid in checking the further spread of the mullein. Our investigations made since then show the mullein to have been here longer, and to be more widely spread, than was then supposed. Still, the plant is readily killed with the hoe, or by simply pulling it up, and our main purpose in writing this account of the weed is to point it out again to the farmers living along Nolin and Green rivers and to request them to destroy it whenever they may observe it on or about their farms.

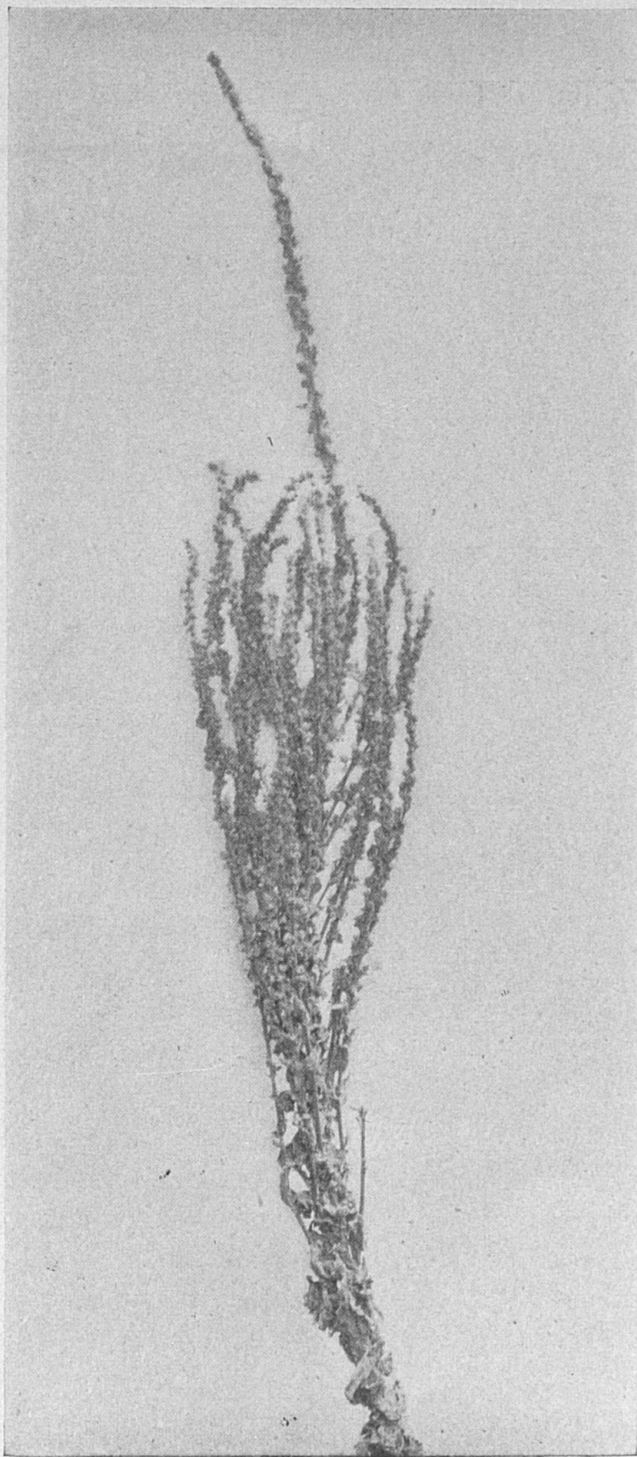
The Station has, while looking into the distribution and character of the woolly mullein, destroyed many thousands of plants, but with other pressing work on our hands it will not be possible for us to give the subject the continuous attention needed unless special appropriations can be made for the purpose, sufficient to hire competent assistance.

Description of the Woolly Mullein and Comparison With the Common Mullein.

The woolly mullein resembles the common species more closely than any other mullein occurring in the Eastern United States. The leaves are of the same general character, being large, elongate, and woolly, but the woolly coat is, in large plants, less abundant than in the common mullein and the color of the leaf more green, i. e., less silvery. The leaves of the recently introduced plant are also more pointed at the tip. The stem of the new mullein is round, not ridged like that of the common mullein, and there is a strong disposition in the new plant to branch, so that large examples become quite



A, woolly mullein, young plant; B, top of same plant, less reduced;
C, common mullein.



Woolly Mullein; top of large plant.

bushy at the top owing to the development of numerous slender flower-bearing branches, of several feet in length (See figures). The flowers of the woolly mullein are like those of the common species in general character, but are scattered instead of being crowded together. They are of a bright orange color, and average larger than those of the common mullein, being sometimes as much as 1.40 inch across.

The flowers of the new mullein expand early in the morning, at which time they are visited by bumble bees, by other smaller bees, and by a small black thrips. The plants are often found growing side by side with the common species, and I have seen some hybrids which combined the characters of the two so that it was impossible to say which species they resembled most.

The new mullein begins to flower early in July when not more than two to three feet high, and at this stage is often unbranched. It continues to produce flowers, and to put out lateral branches at the base of the median flower spike, for six weeks or more, and if growing on good soil often reaches a height of as much as eight feet. An example observed by me measured ten feet and seven inches in height, being the largest mullein of any species I have ever seen.

The species has not yet found its way into American botanies.

2. THE GAPE DISEASE OF YOUNG POULTRY.

BY H. GARMAN, ENTOMOLOGIST AND BOTANIST.

Young chickens are very much troubled in Kentucky with gapes. The disease occurs throughout the State, but is not uniform in its occurrence, being destructive on one farm, while farms adjoining are free from it. On the Experiment Farm at Lexington the disease rarely makes its appearance, while on a place just across a pike the majority of the chicks hatched are some seasons destroyed by it. At my own place again, a mile away, the trouble is very annoying. It appears that once it becomes estab-

lished on land it maintains itself there and thus renders it ill suited to the raising of chickens.

The immediate cause of the trouble is of course the presence of the well known gape worm (*Syngamus trachealis*) in the trachea or windpipe. These worms obstruct the passage of air to and from the lungs and thus occasion the characteristic gasping movements of the suffering chicks. The symptoms and general nature of the trouble are so well known that further reference to them may be dispensed with.

Common Remedies.

The commonly recommended practice of introducing into the trachea a partly stripped feather, or a bluegrass top, and by a twisting motion dislodging and removing the worms does not seem to me after considerable experience with the diseased fowls to be practicable for very young chicks. The trachea is so small and so easily injured that it is impossible to dislodge and remove all of the worms by such means. With the greatest care I have never been able to give affected chicks more than temporary relief in this way.

It has been my experience, however, that chicks generally recover without treatment when they are attacked after they are half-grown, and hence fowls that might from their size be treated successfully with a feather do not require treatment of any sort. It is the very young chicks that suffer most, and the only remedial treatment in their case that seems to me to be successful, is rubbing the neck from time to time with lard or vaseline thoroughly mixed with a little turpentine (3 parts of the lard or vaseline to 1 part of turpentine). This treatment should begin before the disease makes its appearance. It will not help a chick in the last stages of the disease. Pure turpentine will very quickly kill a chick when rubbed on the neck over the trachea, a fact which I

have several times demonstrated on badly affected individuals.

Since my observations on the disease were made I have read a valuable article on gapes and gape worms, written by the French naturalist Megnin. He asserts that the use of pounded garlic with the usual food has been made to completely eradicate the disease among pheasants in Europe. He recommends the use of one garlic bulb to ten pheasants each day, and the same proportion would in all probability be sufficient in the case of the common chicken. He supplements this treatment with special care in the matter of drinking water, using only pure water and changing it several times a day.

The Source of Gapes.

My curiosity as to how chickens contracted the disease was aroused by the observation noted above as to its irregular occurrence. The current belief among naturalists is that the worms are in soil and are picked up with food. No doubt this is true while the disease is present on a place, but I have known instances in which flocks were very badly affected on land where chickens had not been raised for years. How did these minute worms persist in soil that is each year dried and parched by the sun's heat? It is known that they can not endure either heat or drought. It is hardly probable that they migrate like earthworms down into the soil in summer and reappear again at the surface during fall and spring, when the surface soil is damp. It is a natural supposition that they may enter the bodies of insects, mollusks, or earthworms, like some other parasitic worms, and be received by poultry with such food. Yet Megnin asserts that they do not pass any stage of their existence in the bodies of any animals other than birds.

When the disease is under way among a brood of chicks it is beyond doubt conveyed by way of drinking

water and food from affected fowls to others. Chicks suffering from gapes may sometimes be observed to dislodge worms and discharge them from their mouths during spells of sneezing. According to Megnin's observations young hatched from the eggs in the bodies of these discharged worms may live for some time in the drinking water, where they swim about like vinegar eels, ready to be taken into the stomachs of fowls.

These facts in the history of the worms show why dissolving copperas in the drinking water, isolating affected fowls, and changing the quarters of the others sometimes have the effect of checking the spread of the disease.

But when the young gape worms are already abundant in the soil such treatment will not avail unless the chicks can be kept from the ground.

Chicks Reared on a Plank Floor Not Attacked by the Gape Worm.

I find by experiment that it is possible to prevent the trouble completely on my place at Lexington by keeping chicks on a board floor from the time they are hatched until they are large enough to endure the attacks of the worms.

Chicks hatched by two hens June 5-7, 1897, were taken from the nests before they had an opportunity to get to the ground, and confined in two compartments of the same coop. One compartment was provided with a board floor; in the other the chicks were allowed the freedom of the ground. There were twenty chicks in all divided equally between the two hens and confined in the two compartments, which were separated by wire netting. Immediately after the experiment was started three of the lot on the floor managed to get into the other compartment and were allowed to remain. There were thus on the plank floor seven chicks, while confined on the ground beside them were thirteen. One of the latter lot died from

some unknown trouble soon after they hatched, leaving only twelve for experiment.

The two lots were treated alike in every respect except in the matter of the floor and in the character of food. Those on the plank floor received the accustomed food given young chicks, namely, corn meal mixed with water and scraps of bread, potato and meat from the table. After they had grown somewhat, a little oats was given them occasionally. The chicks on the ground received the same kind of food, except that they had in addition a daily ration of earthworms. The following is a record of observations on the lot to which earthworms were fed:

June 23. One of the chicks observed to be badly affected with the gapes. It died during the following night. Several others slightly affected.

June 24. A second chick of the same lot nearly dead from gapes. It was removed and chloroformed, when its trachea was found to contain gape worms.

June 29. A third chick of this lot was found dead, and on examination its trachea was found partly filled with the worms. A fourth, nearly dead from the disease, was chloroformed and it also had worms in the trachea. Several of the remainder were at this date observed to be affected, and probably not a single one was entirely free from the trouble.

June 30. Three more chicks were so badly affected that it was decided to remove and destroy them. All had gape worms in the trachea.

July 1. Three of the five remaining chicks were affected and were removed and chloroformed. The tracheæ of all contained gape worms.

July 3. One of the two remaining chicks was affected. It was removed and destroyed like the others.

July 5. The last one of the lot was removed and chloroformed and also had gape worms in the trachea.

During this time not a single chick of the seven kept

on the plank floor became affected with the disease. The hen kept with them, however, appeared to suffer from the close confinement and cramped quarters, and subsequently died. Her trachea did not contain gape worms.

Conclusion.

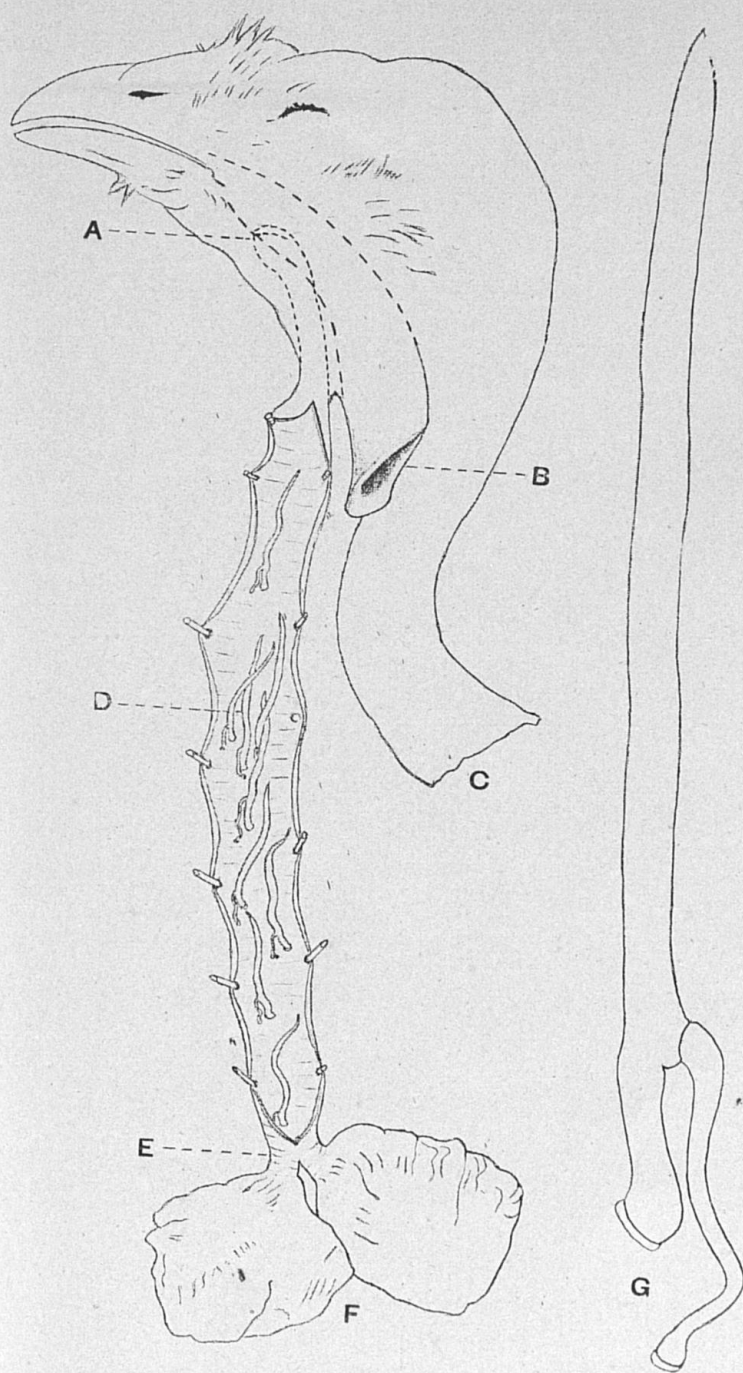
It is evident that the chicks in the compartment without a floor obtained the gape worms either from the ground or else from the earthworms which were fed to them. At the time my experiment was made I had not seen Megnin's interesting account of the gape worm infesting the European pheasant, and while I must admit that the experiment here recorded does not prove that gape worms live within the bodies of earthworms and are by means of the latter conveyed to the lungs and tracheæ of chickens, yet I am far from convinced by anything observed by Megnin that they may not be thus conveyed.

Convincing evidence can be obtained by confining two lots of the chicks on plank floors, one to be fed earthworms, the other not. A test of this sort was started last spring, after the other was completed, but a drought set in at that time and drove the earthworms so deep into the soil that enough could not be secured. The matter will be taken up again next spring.

The result of value to the farmer obtained from this preliminary experiment is, that keeping chicks, for several weeks after they hatch, on a plank floor will prevent the gapes. It is my present opinion that the same result would be obtained by simply elevating an earthen floor above the surrounding level so that it would not retain moisture. It must be remembered, though, that after the disease is established in a brood it will be conveyed from one to another through the medium of food and drink, and in such case a plank floor would not alone save it. In case the disease should be introduced by chicks which had contracted it elsewhere the proper treatment would be to isolate affected individuals as soon as discovered and medicate the drinking water of the rest.



Young chick suffering from gapes. Photographed from life by H. Garman.



Dissection of a chick affected with gapes, the trachea pinned open. A, the glottis or opening through which air enters the trachea from the mouth; B, the cut end of the oesophagus; C, the cut neck; D, the open trachea with gape worms attached to its wall; E, the bronchial or lung tubes, one for each lung; F, the lungs; G, a pair of gape worms, the small male being permanently attached to the female. Both figures enlarged. H. GARMAN, del.

KENTUCKY
AGRICULTURAL EXPERIMENT STATION

OF THE

STATE COLLEGE OF KENTUCKY.

BULLETIN NO. 71.

ANALYSES OF COMMERCIAL FERTILIZERS.

1. Official Analyses.
 2. Analyses of Other Samples.
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LEXINGTON, KENTUCKY.

DECEMBER, 1897.

KENTUCKY

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Address of the Station—LEXINGTON, KY.

NOTICE.

The Bulletins of the Station will be mailed free to any citizen of Kentucky who sends his name and address to the Station for that purpose.

Correspondents will please notify the Director of changes in their post-office address, or of any failure to receive the Bulletins.

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KENTUCKY AGRICULTURAL EXPERIMENT STATION,
LEXINGTON, KY.

BULLETIN No. 71.

Commercial Fertilizers.

I. OFFICIAL ANALYSES.

Since the publication of Bulletin No. 68 the following analyses have been made for manufacturers in compliance with the fertilizer law, and these fertilizers were legally on sale in the State during the past season, in addition to those reported in the bulletin referred to above.

The values for the "essential ingredients" for 1898 have not been changed, and are as follows:

Soluble and reverted phosphoric acid in mixed fertilizers, 7 cents; in plain acid and unacidulated phosphates, 5 cents per pound.

Insoluble phosphoric acid in mixed fertilizers, $2\frac{1}{2}$ cents; in plain acid phosphates, nothing; in Orchilla guano, 3 cents; in other unacidulated phosphates 2 cents per pound.

Phosphoric acid in fine bone, 4 cents; in medium bone, 3 cents per pound.

Nitrogen in all fertilizers, $17\frac{1}{2}$ cents per pound.

Potash in all fertilizers, from sulphate, 7 cents; from muriate, 6 cents per pound.

TABLE I.—Raw Bone Manures, Etc.

Station Number.	NAME AND ADDRESS OF MANUFACTURER.	NAME OF BRAND.	POUNDS IN THE HUNDRED.						Estimated Value Per Ton.
			Phosphoric Acid.			Equivalent to Bone Phosphate.	Nitrogen.	Equivalent to Ammonia.	
			In Fine Bone.	In Medium Bone.	Total.				
3925	A. D. Adair & McCarty Bros., Atlanta, Ga.....	Adair's Pure Animal Bone Meal	23.50	2.85	26.35	57.56	3.25	3.95	\$31.89
3930	Booth Bros., St. Bethlehem, Tenn.....	Fine Ground Bone Meal.....	26.65	3.29	29.94	65.38	1.70	2.06	29.24
	Wm. Casler, Louisville, Ky.....	See R. H. Hoskins.....	.....	.....	.....	.....	.....	.....	.....
3912	The Currie Fertilizer Co., Louisville, Ky.....	Currie's Fine-Grained Raw Bone Meal.....	21.09	2.50	23.59	51.52	2.15	2.61	25.90
3913	Same	Currie's Raw Bone Meal.....	10.98	11.43	22.41	48.95	3.94	4.78	29.43
3960	Empire Carbon Works, St. Louis, Mo.....	Empire Pure Raw Bone Meal...	22.06	.....	22.06	48.17	3.85	4.67	31.13
3939	R. H. Hoskins, Louisville, Ky	Champion Raw Bone Meal.....	22.26	.....	22.26	48.62	4.53	5.50	33.67
3917	Louisville Fertilizer Works, Louisville, Ky	Bone Meal.....	16.41	1.70	18.11	39.56	3.01	3.65	24.69

Commercial Fertilizers.

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3939	R. H. Hoskins, Louisville, Ky	Champion Raw Bone Meal.....	22.26		22.26	48.62	4.53	5.50	33.67
3917	Louisville Fertilizer Works, Louisville, Ky	Bone Meal.....	16.41	1.70	18.11	39.56	3.01	3.65	24.69
3941	Same.....	Raw Bone	13.95	5.24	19.19	41.91	4.26	5.17	29.21
3935	A. B. Mayer Mfg. Co., St. Louis, Mo.....	Anchor Brand Pure Bone Meal..	16.25	5.42	21.67	47.33	3.76	4.56	29.41
3892	Michigan Carbon Works, Detroit, Mich.....	Banner Raw Bone Flour.....	7.53	13.99	21.52	47.00	4.28	5.20	29.39
3928	National Fertilizer Co., Nashville, Tenn.	Pure Bone Meal.....	5.23	18.03	23.26	50.79	3.87	4.70	28.55
3942	E. Rauh & Sons, Indianapolis, Ind.....	Pure Raw Bone Meal.....	11.49	13.43	24.92	54.43	4.00	4.86	31.25
3931	J. F. & W. H. Singer, Nashville, Tenn.....	Singer's Standard Raw Bone Meal.....	11.91	8.41	20.32	44.37	3.83	4.65	27.99

TABLE II.—Complete Fertilizers, Superphosphates, Etc.

TABLE II.—Complete Fertilizers, Superphosphates, Etc.										
POUNDS IN THE HUNDRED.										
Station Number.	NAME AND ADDRESS OF MANUFACTURER.	NAME OF BRAND.	Phosphoric Acid.			Nitrogen.	Equivalent to Ammonia.	Potash.		Estimated Value per Ton.
			Soluble.	Reverted.	Insoluble.			From Sulphate.	From Muriate.	
3943	A. D. Adair and McCarty Bros., Atlanta, Ga.....	Furman Soluble Bone with Ammonia and Potash.....	8.51	1.97	3.94	1.07	1.30	.....	2.48	\$23 37
3967	American Fertilizer Co., Washington, D. C.....	Natural Plant Food.....	.....	0.67	17.65	.....	.....	.....	.....	7 73
3891	Geo. S. Bartlett, Cincinnati, O.....	Indian Brand Gilead Phosphate.....	4.50	4.19	5.05	3 20	3.88	.....	2.32	28 68
3932	Crocker Fert. & Chemical Co., Buffalo, N. Y.....	Universal Grain Grower..	4.53	2.47	0.73	0.88	1.07	.....	3.62	17 59
3927	The Goulding Fertilizer Co.Ltd., Pensacola, Fla	Goulding's Bone Compound..	5.03	3.03	7.10	2.11	2.56	.....	2.13	24 78
3952	The Loudonback Fertilizer Co., Urbana, O.	Urbana Bone Phosphate and Potash	5.92	5.93	3.03	2.65	3.22	1.84	1.00	31 17
3926	The Louisville Fertilizer Works, Louisville, Ky..	Soluble Bone and Potash	3.39	3.64	2.99	1.46	1.77	1.60	1.04	19 94
3936	A. B. Mayer Mfg. Co., St. Louis, Mo.....	Anchor Brand Corn and Wheat Grower.....	1.82	4.40	5.41	3.26	3.96	.20		25 91

Commercial Fertilizers.

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3936	A. B. Mayer Mfg. Co., St. Louis, Mo.....	Anchor Brand Corn and Wheat Grower.....	1.82	4.40	5.41	3.26	3.96	.20		25 91
3953	Meridian Fert. Factory, Meridian, Miss.....	Standard Home Mixture Guano.....	9.45	1.38	1.07	2.67	3.24	.....	2.75	28 35
3940	National Fertilizer Co., Nashville, Tenn.....	Wheat Grower.....	8.60	2.48	4.50	2.10	2.55	.....	2.96	28 66
3951	Read Fertilizer Co., Charleston, S. C.....	Blood and Bone Ammoniated Superphosphate.....	5.07	2.18	2.65	1.71	2.08	.....	.....	17 47
3894	The J. & F. Schroth Pack- ing Co., Cincinnati, O..	Wheat and Corn Grower.....	2.38	4.40	7.45	4.17	5.06	.....	5.21	34 07
3895	Same.....	Queen City Phosphate.....	2.47	4.48	7.16	3.46	4.20	.....	2.70	28 66
3896	Same.....	Schroth's Special.....	3.10	3.17	9.25	1.97	2.39	.....	1.84	22 52
3890	Southern Fertilizer Co., Rome, Ga	Greer's Compound Fertilizer..	11.92	4.45	2.28	.....	.....	.....	2.25	26 76

II. ANALYSES OF OTHER SAMPLES.

The law regulating the sale of commercial fertilizers in this State provides (Sec. 7) that: "Any agriculturist, a purchaser of any commercial fertilizer in this State, may take a sample of the same, under the rules and regulations of the Director of the said Experiment Station, and forward the same to the Experiment Station for analysis, which analysis shall be made free of charge." Under this provision a number of samples have been analyzed from time to time, and the results of these analyses are published in the following pages.

Here follows, first, a brief description of each sample, and, second, the analyses in tabular form. For convenience of reference, the "station number" of each sample is given, and all brands of the same manufacturer are arranged together. The names of the manufacturers are placed in alphabetical order in the description of the samples, and following each manufacturer's name are the brands of his make that were analyzed.

It is necessary to compare the analysis of each sample with the "official analysis" on the tags attached to the sacks from which the sample was taken, because it is not possible for the manufacturers to make the same fertilizer perfectly uniform from year to year, and any fertilizer is, therefore, liable to vary somewhat in composition; also, because the values assigned to the "essential ingredients" in calculating the "estimated value per ton" are subject to change from time to time. *This is the reason why a tag from one of the packages sampled must be sent with each sample for analysis.*

In the following table we have given in the first column the name of the brand, next, where the sample was taken; then the "station number," and, lastly, the analysis and valuation. The same order is preserved in

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the table as in the description of the samples, hence it is not necessary to repeat the name of the manufacturer. In the case of each brand, the official analysis is first given, in *bold faced type*, for comparison. This official analysis is the same as the analysis that was on the tag attached to the sack from which the sample was taken.

M. A. SCOVELL, *Director*.

A. M. PETER, }
H. E. CURTIS, } *Chemists.*

December 31st, 1897.

DESCRIPTION OF SAMPLES.

A. D. ADAIR & McCARTY BROS., Atlanta, Ga.

No. 3897. Farish Furman Formula, sent by H. L. J. Hille, Roaring Spring, Ky. Tag sent corresponded to No. 2976.

THE ARMOUR FERTILIZER WORKS, Chicago, Ill.

No. 3962. Ammoniated Bone with Potash, sent by M. D. Parr, White Mills, Ky. Tag sent corresponded to No. 3726.

THE LOUISVILLE FERTILIZER WORKS, Louisville, Ky.

No. 3966. Raw Bone, sent by G. W. Beard, Hardinsburg, Ky. Tag sent corresponded to No. 3941.

NATIONAL FERTILIZER CO., Nashville, Tenn.

No. 3977. Wheat Grower, sent by W. M. Darby, Cave Spring, Ky. Tag sent corresponded to No. 3940.

READ FERTILIZER CO., Charleston, S. C.

No. 3976. Alkaline Bone, sent by Howard Brame, Gracey, Ky. Tag sent corresponded to No. 3809.

WM. SKENE & CO., Louisville, Ky.

No. 3846. Skene's Complete Plant Food, or Perfect Tobacco, Potato and Hemp Grower, sent by R. C. Cooke, Elmo, Ky. Tag sent corresponded to No. 3764.

TABLE III.—Farmers' Samples, Etc.

POUNDS IN THE HUNDRED.													
NAME OF BRAND.	WHERE SAMPLED.	Station Number.	Phosphoric Acid.						Nitrogen.	Equivalent to Ammonia.	Potash.		Estimated Value per Ton.
			In Fine Bone.	In Medium Bone.	Available.	Insoluble.	Total.	From Sulphate.			From Muriate.		
Farish Furman Formula.	Official, 1895.....	2976.	.....	.....	12.51	1.56	14.07	.....	.....	.....	2.90	21.77	
	Roaring Spring	3897.	.....	.....	12.19	2.11	14.30	.....	.....	.....	4.54	23.58	
Ammoniated Bone with Potash.	Official, 1897.....	3726.	.....	.....	9.37	3.24	12.61	3.32	4.03	2.50	.....	29.86	
	White Mills.....	3962.	.....	.....	7.46	3.95	11.41	3.32	4.03	2.02	.....	26.87	
Raw Bone.	Official, 1897	3941.	13.95	5.24	.....	.....	19.19	4.26	5.17	.....	.....	29.21	
	Hardinsburg.....	3966.	12.28	9.54	.....	.....	21.82	3.64	4.42	.....	.....	28.28	
Wheat Grower.	Official, 1897.....	3940.	.....	.....	11.08	4.50	15.58	2.10	2.55	.....	2.96	28.66	
	Cave Spring	3977.	.....	.....	13.00	1.52	14.52	1.38	1.68	.....	2.72	27.05	
Alkaline Bone.	Official, 1897	3809.	.....	.....	10.33	2.34	12.67	.....	.....	.....	2.27	18.35	
	Gracey	3976.	.....	.....	9.63	2.42	12.05	.....	.....	.....	2.28	17.43	
Skene's Complete Plant Food.	Official, 1897	3764.			6.95	1.39	8.34	4.18	5.07	15.01		46.07	
	Elmo	3846.			6.20	1.39	7.59	4.69	5.69	14.89		46.65	

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Baker, F
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