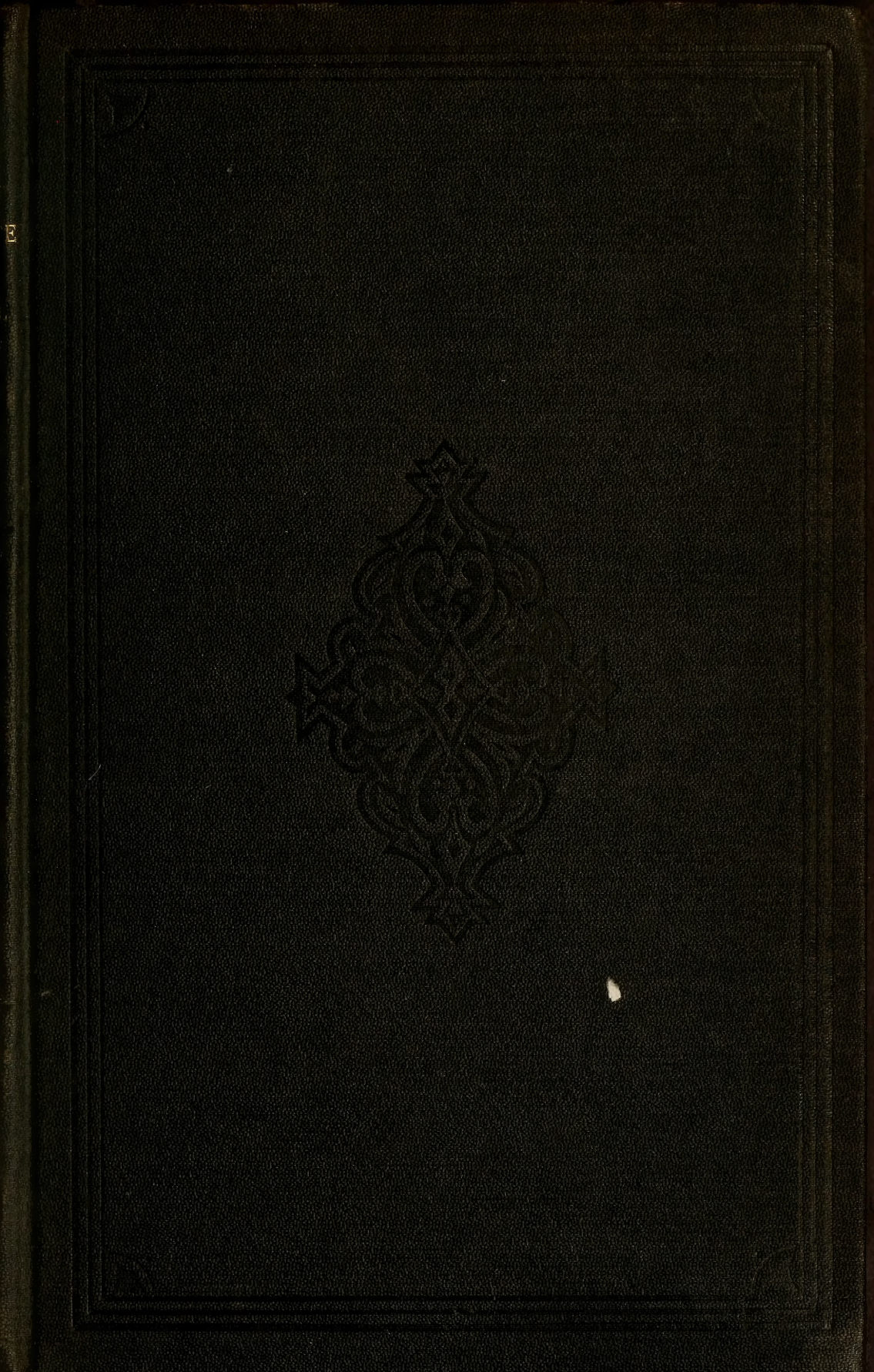

ANNUAL REPORT

OF THE

MAINE STATE COLLEGE

FOR THE

YEAR 1895

PART II

Report of the Director of the Agricultural Experiment Station.

AUGUSTA:
BURLEIGH & FLYNT, PRINTERS TO THE STATE
1896.

MAINE STATE COLLEGE.

AGRICULTURAL EXPERIMENT STATION.

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MRS. J. HAMLIN WAITT.....Clerk and Stenographer

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TREASURER'S REPORT.

Maine State College Agricultural Experiment Station in account with the United States appropriation, 1894–5:

Dr.

To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1895, as per act of Congress approved March 2, 1887	$15,000 00

Cr.

By salaries:		
(a) Director and administration officers	$1,705 84	
(b) Scientific staff	5,922 74	
(c) Assistant to scientific staff	1,708 35	
(d) Special and temporary services	221 00	
Total		$9,557 93
Labor:		
(a) Monthly employes	$164 62	
(c) Hourly	601 03	
Total		765 65
Publications:		
(a) For printing	$145 50	
(c) For envelopes for bulletins and reports	45 00	
(d) Other expenses	17 60	
Total		208 10
Postage and stationery		275 67
Freight and express		180 97
Heat, light and water:		
(a) Heat	$312 44	
(c) Water	100 00	
Total		412 44
Chemical supplies:		
(a) Chemicals	$106 56	
(b) Other supplies	179 55	
Total		286 11

Seeds, plants, and sundry supplies:		
(a) Agricultural	$ 44 85	
(b) Horticultural	451 78	
(c) Botanical	15 92	
(d) Entomological	19 25	
Total		$531 80
Fertilizers		167 65
Feeding stuffs		508 02
Library		111 12
Tools, implements, and machinery:		
(b) New purchases		135 31
Furniture and fixtures		118 35
Scientific apparatus		417 78
Live stock:		
(b) Cattle	$150 00	
Total		$150 00
Traveling expenses:		
(a) In supervision of Station work	$121 99	
(b) In attending various meetings	92 86	
Total		214 85
Contingent expenses		209 31
Building and repairs:		
(a) New buildings	$458 41	
(b) Improvements	96 92	
(c) Repairs	193 61	
Total		748 94
Totals		$15,000 00

REPORT OF DIRECTOR.

A. W. Harris, Ph. D., President Maine State College:

SIR:—I submit herewith a report of the work of the Maine Experiment Station for the year 1895.

It is gratifying to note that the scope and influence of the work of the station are increasing yearly. This is caused in part by new legislation affecting the station and in part by the fact that scientific appliances and information are becoming more and more a necessary factor of successful agriculture. Not only are the difficult questions of current agriclutural practice largely referred to science for an answer,rather than to popular beliefs as formerly was the case, but there is a pressing demand that the boundaries of knowledge be enlarged in matters pertaining to agriculture. Besides, the scientist, especially the chemist, is now being charged with the execution of laws affecting the farmer's interests. In all these directions the Maine Station has been more or less active.

FERTILIZER INSPECTION.

As has been stated in previous reports, it has been found that an analysis fee of $15 for each brand of fertilizer sold in the State to the extent of thirty tons or more is not sufficient to pay the expenses involved in an official inspection according to the terms of the law. Accordingly the legislature of 1895 was asked to so amend the law that the analysis fee should be $20 for each brand sold to the extent of ten tons or more.

The change in the analysis fee was secured, but through a clerical or other error, the thirty ton limit was retained. It now appears that the receipts from analysis fees will just about cover the proper expenses of a painstaking execution of the law. The indications are at this time that more brands of fertilizers will be sold in 1896 than ever before. Old companies are increasing the number of brands they are offering and new companies are entering the State. Confusion is being added to confusion, and the day of a rational fertilizer trade appears to be as far away as ever. The number of brands paying a fee for 1896 probably will not be far from eighty, while the brands offered for sale in the State will undoubtedly considerably

exceed one hundred. This means that perhaps thirty brands are exempted from the payment of the analysis fee as coming within the thirty ton limit. The terms of the law require, however, that these non paying brands shall be inspected, consequently it is possible for a manufacturer, by selling a small amount of a large number of brands, to augment the work of inspection entirely out of proportion to the analyses fees paid. The text of the fertilizer may be found in this report.

The Inspection of Chemical Glass Ware in Creameries.

The bill introduced into the last legislature by Hon. Z. A. Gilbert, chairman of the committee on agriculture, requiring for one thing an inspection of the graduated glass ware used by creameries in determining the fat content of milk and cream, became a law. The director of this station is charged with the execution of this part of the law, either by himself or by some one he may designate.

Mr. J. M. Bartlett, one of the station chemists, was named to attend to this duty.

There has been very generally a disposition manifested on the part of creamery managers to comply with the terms of the law. The results so far reached justify the existence of the law, and testify to the wisdom of its promoters. The text of the law is printed herewith.

Investigations in Human Nutrition.

Acting upon recommendations made by Secretary Morton in 1893 Congress subsequently appropriated $10,000, to be used in making investigations in human nutrition. Professor W. O. Atwater of Wesleyan University, Middletown, Conn., was placed in the immediate charge of the expenditure of this fund and it may properly be considered a matter for congratulation that he regarded the Maine Experiment Station so favorably as to entrust to it a portion of this money to be used in conducting investigations.

Mr. F. C. Moulton, a graduate of the Maine State College, was engaged as an assistant to aid in this line of inquiry. Work was begun in February 1895 and has been industriously and faithfully prosecuted throughout the year, its object being to study the effect of the source of the food supply upon the amount and cost of the food consumed in the college boarding house, especial attention being given to the influence of an abundant supply of milk upon the amount and cost of the dietary.

The results reached indicate in general that the free use of milk does not increase food consumption and cheapens the cost of raw materials.

The Results for the Year.

The principal features of this report are the following: The result of an important study in plant nutrition, covering the work of two years, this being an attempt to learn something about the feeding capactiy of certain families and species of plants; an investigation into the influence of the ration upon the growth and composition of the animal body; experiments in feeding milch cows with a variety of foods, especially a silage corresponding to the Robertson Mixture; horticultural experiments; and a report concerning certain injurious insects and fungi, part of which consists of original observations on the life history of a Trypeta which is doing much damage to currants in the vicinity of Orono.

Owing to the absence of Professor Munson, the horticultural work has been less in 1895 than in previous years.

The activities of the station have been directed largely towards either the verification of existing beliefs or the discovery of new facts, and in so doing the station has certainly exercised its true function.

The director of the station feels that he should express his sincere appreciation of the faithful and loyal co-operation of his associates in prosecuting the work committed to their care.

W. H. JORDAN, Director.

Maine State College,
Orono, Me., December 31, 1895.

INVESTIGATION ON THE FORAGING POWERS OF SOME AGRICULTURAL PLANTS FOR PHOSPHORIC ACID.

L. H. Merrill.

Several years ago Professor Balentine, then agriculturist of this station, began a series of experiments for the purpose of determining the "foraging power" of certain plants for phosphoric acid. The results then obtained were published in the annual report of this station for 1893.

These investigations were considered of such importance that after Professor Balentine's death the work was extended and continued. Eight species of plants were chosen, representing four orders: peas and clover (Leguminosae); turnips and ruta bagas (Cruciferae); barley and corn (Gramineae;) tomatoes and potatoes (Solanaceae). The plants were grown in the forcing house in wooden boxes, fourteen inches square and twelve inches deep, each containing 120 pounds of sand. This sand was obtained from a knoll near by, and having been taken from a depth of three or four feet was nearly free from organic matter. It was found to contain a very little phosphoric acid, but the total amount present was so far below what would be required by a vigorous plant that it is doubtful if its presence could be considered a disturbing factor. Owing to its almost complete inertness and its inability to puddle or pack, this soil has proved a very satisfactory medium, and was thought preferable to the mixture of sphagnum and coal ashes sometimes used in pot experiments.

Three forms of phosphates were used:

A. Acidulated Florida rock, containing 20.60 per cent. total phosphoric acid; 14.97 per cent. soluble; 3.70 per cent. insoluble; 16.90 per cent. "available."

B. Crude, finely ground Florida rock (Floats,) containing 32.88 per cent. phosphoric acid. This was obtained from the commercial ground rock by stirring it with water, allowing the coarser particles to subside and then pouring off the turbid water. The "Floats" are the sediments deposited from these washings.

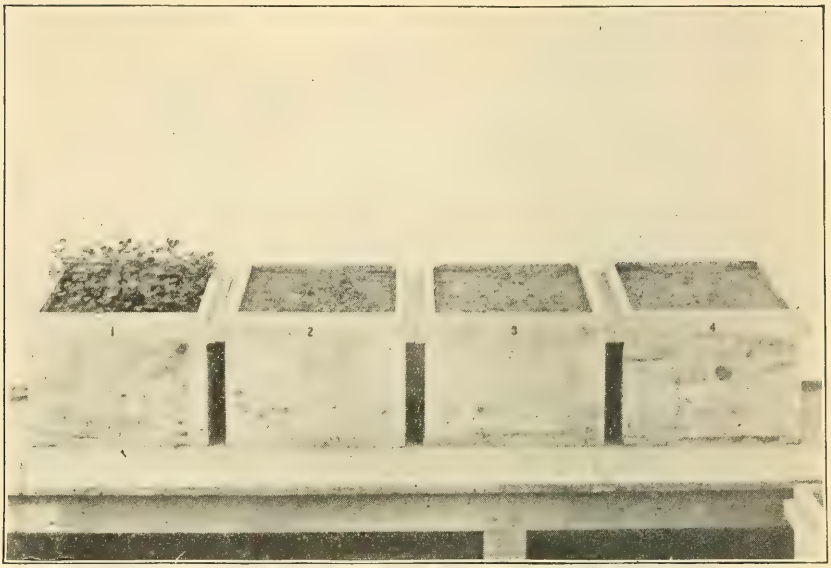
C. A phosphate of iron and alumina, containing 49.58 per cent. phosphoric acid, a large part of which, 42.77 per cent., was soluble in ammonium citrate. This ready solubility in ammonium citrate is brought about by roasting the phosphate. It undergoes a

Maine State College Experiment Station Report, 1895. Plate 1.

Peas.

Box 1. Soluble Phosphoric Acid.
Box 2. Insoluble Phosphoric Acid—Florida Rock.
Box 3. Insoluble Phosphorate of Iron and Alumina.
Box 4. No Phosphate added.

Clover, immature.



Clover, mature.

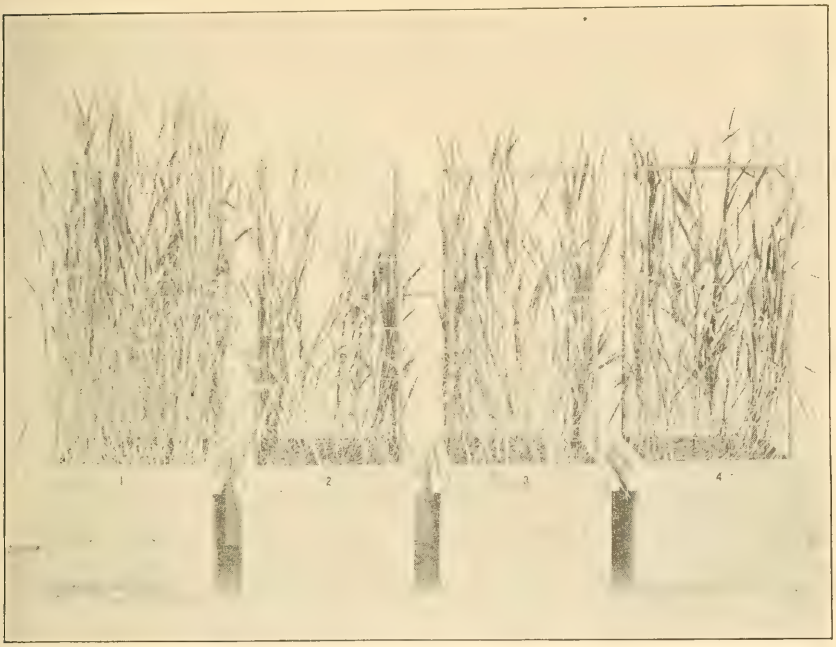
Box 1. Soluble Phosphoric Acid.
Box 2. Insoluble Phosphoric Acid—Florida Rock.
Box 3. Insoluble Phosphorate of Iron and Alumina.
Box 4. No Phosphate added.

Turnips.

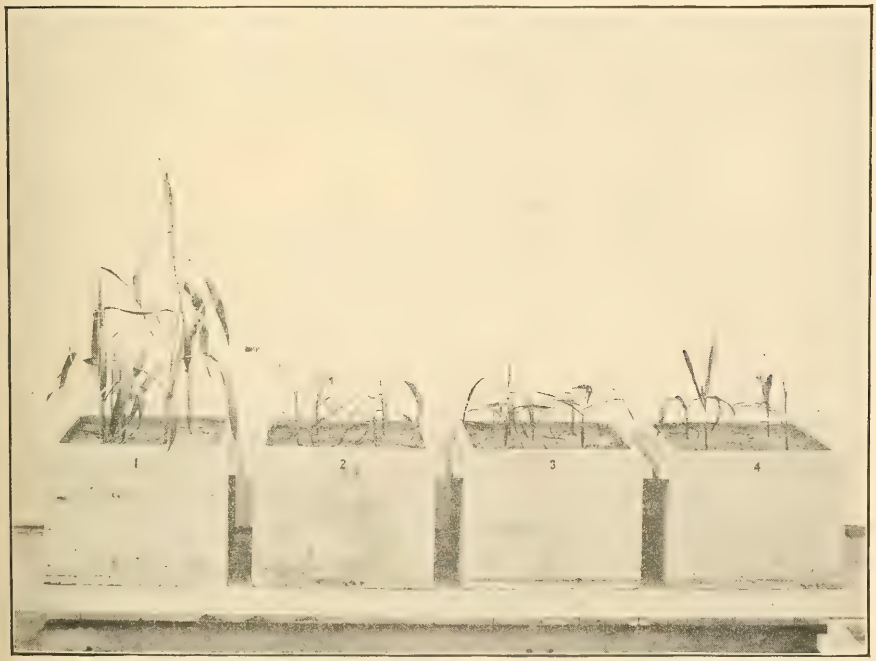
Ruta-bagas.

Box 1. Soluble Phosphoric Acid.
Box 2. Insoluble Phosphoric Acid—Florida Rock.
Box 3. Insoluble Phosphorate of Iron and Alumina.
Box 4. No Phosphate added.

Barley.



Corn.



Box 1. Soluble Phosphoric Acid.
Box 2. Insoluble Phosphoric Acid—Florida Rock.
Box 3. Insoluble Phosphorate of Iron and Alumina.
Box 4. No Phosphate added.

Tomatoes.

Potatoes.

Box 1. Soluble Phosphoric Acid.
Box 2. Insoluble Phosphoric Acid—Florida Rock.
Box 3. Insoluble Phosphorate of Iron and Alumina.
Box 4. No Phosphate added.

change on standing whereby the phosphate gradually becomes less soluble in the citrate solution.

Ninety-six boxes were used, twelve for each kind of plant. In the first box the acid rock was used; in the second, the crude rock; in the third, the phosphate of iron and alumina; in the fourth, no phosphate. The next four boxes were treated in the same manner, and so on to the end. Thus it will be seen that for each kind of plant there were three boxes which received the same treatment.

Twenty grams of the crude Florida rock, containing 6.576 grams total phosphoric acid, were used for a single box. Of the other phosphates such quantities were used as contained the same total amount, 6.576 grams, of phosphoric acid.

To each box were also added: Ten grams sodium nitrate; five grams potassium chloride; five grams magnesium sulphate. To the boxes containing the phosphate of iron and alumina and to those containing no phosphate were also added ten grams calcium sulphate. All these materials were carefully mixed with the screened sand before it was placed in the boxes.

The clover and barley were planted in seven rows of seven plants each, or forty-nine plants to each box. The peas were thinned to nine plants. Of the other plants, four were grown in each box. All the conditions were made as uniform as possible in order that whatever differences were observable might fairly be attributed to the differences in the phosphates used. The seed was carefully selected, that only being used which was well formed and of uniform size. Such leaves as ripened before the plants matured were removed, dried and added to the plants when harvested. No attempt was made at pollination. As very few insects were present during the growth of the plants, the fruiting, as might have been expected, was very irregular.

When the most advanced plants of each species had reached their highest development, all the plants of that species were harvested. The plants were carefully dried, weighed and ground. The moisture was determined in each sample and the water free weights calculated.

The experiments were continued through three periods. In the first period the barley matured its heads, and many of the pea-pods were well filled. The second period extended through the shortest days of the winter, when the lack of sun and the lower temperature were unfavorable to the best development of the corn and tomatoes. The third period was made shorter than the others, and none of the plants reached their full development.

At the close of the second period the clover was not harvested, but was allowed to grow on through the third period.

All but one of the photographs from which the accompanying cuts were made were taken at the close of the second period. The second cut of the clover is from a photograph made at the end of the third period, and represents the same plants as those shown in the preceding illustration.

TABLE I.

YIELD OF DRY MATTER IN GRAMS FOR EACH OF THE THREE PERIODS.

A represents the acid rock, B the crude rock, C the phosphate of iron and alumina, D no phosphate.

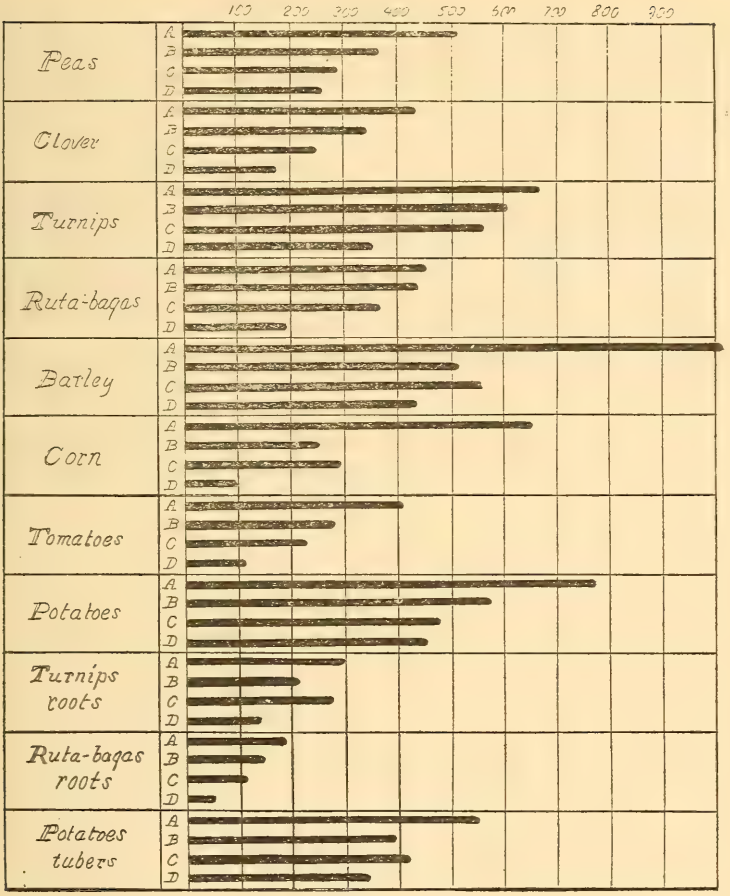
	First Period.				Second Period.				Third Period.			
	A	B	C	D	A	B	C	D	A	B	C	D
Peas	193.3	185.0	185.4	179.4	253.1	132.1	56.7	53.2	54.3	49.4	41.4	28.4
Clover	136.3	120.0	103.6	63.6	296.8	218.9	148.2	101.6				
Turnips	228.8	207.7	226.3	154.1	277.9	245.3	201.9	86.2	157.8	151.7	133.3	117.0
Rutabagas	154.9	167.6	176.8	132.0	240.0	215.6	132.5	31.0	61.0	52.5	55.8	30.1
Barley	335.8	269.5	259.1	197.0	500.0	131.5	164.2	127.2	179.6	113.1	136.1	112.6
Corn	491.1	228.9	261.7	61.6	55.5	7.4	6.3	6.3	106.9	17.6	25.8	24.9
Tomatoes	200.9	177.5	160.6	33.3	63.7	4.7	1.8	1.4	141.3	93.7	73.7	73.2
Potatoes	341.7	254.5	274.2	181.1	285.7	143.3	127.7	141.7	151.5	164.6	64.8	129.0
Turnips, roots	98.5	47.7	117.3	71.0	161.3	137.5	121.9	40.1	40.0	25.1	31.0	21.2
Rutabagas, roots	51.5	35.1	53.7	39.5	130.0	101.9	50.1	8.4	5.6	4.3	3.5	1.5
Potatoes, tubers	246.4	196.8	214.6	135.8	242.1	124.8	113.2	125.8	67.0	71.7	91.4	83.1

TABLE II.

TOTAL YIELD OF DRY MATTER FOR THE THREE PERIODS.

	A	B	C	D
Peas	500.7	366.5	283.5	261.0
Clover	433.1	338.9	251.8	165.2
Turnips, whole plant	664.5	604.7	561.5	357.3
Ruta bagas, whole plant	455.9	435.7	365.1	193.1
Barley	1015.4	514.1	559.4	436.8
Corn	653.5	253.9	293.8	92.8
Tomatoes	405.9	275.9	236.1	107.9
Potatoes, whole plant	778.9	562.4	466.7	451.8
Turnips, edible roots	299.8	210.3	270.2	132.3
Ruta bagas, edible roots	187.1	141.3	107.0	49.4
Potatoes, tubers	555.5	393.3	419.2	344.7

Table I shows the yield for each kind of plant grown, for each period. In Table II the weights for the three periods are condensed. The diagram which follows is designed to show graphically the same results as are given in Table II. Following the diagram may be seen the photographic illustrations showing the plants as they appeared at the time of harvesting.



A study of the tables and diagram shows:

1. All the plants receiving the phosphate of iron and alumina show a gain over those receiving no phosphate. This effect was most marked with the corn, the yield being three times as great as where no phosphate was used. The weight of the tomato plants was doubled. The turnips and ruta-bagas responded vigorously, the crop of roots being doubled. On the other hand, the peas and potatoes gained but little.

2. All the plants receiving the insoluble Florida rock show a gain over those to which no phosphate was given, the crops of clover ruta-bagas, corn, tomatoes and ruta-baga roots being more than doubled. The barley, potatoes and especially the potato tubers gained but little. All the plants showed a gain over those receiving the phosphate of iron and alumina except in the case of the barley, corn, turnip roots and potato tubers.

3. All the plants were benefited by the addition of the acid rock. The barley and corn show the most marked increase, the yield being double that from the crude rock. The ruta-bagas and the turnips derived nearly as much benefit from the crude rock as from the acid rock.

The effect of the acid rock was very marked, with all the plants grown, those receiving it, in nearly all cases, at once taking the lead and keeping it to the end. The plants were darker green in color, and the tubercules, which were developed on the roots of nearly all the leguminous plants, were larger and much more numerous. It was noticeable, however, that in some cases, especially with the clover, turnips and ruta-bagas, the good effects of the acid rock were more marked during the first few weeks of growth than at a later stage, when the roots had become more fully developed and had begun to forage for themselves. It would appear that the young plants feed but little upon the insoluble phosphates; but that the organic acids present in the sap of the roots exert a solvent action upon the insoluble phosphates in the soil, gradually converting them into available forms.

COMMENTS.

W. H. JORDAN.

It is often difficult, perhaps impossible in some instances, to so display experimental data that they shall convey to the reader the full significance of the results reached. This appears to be peculiarly the case with the forcing house experiments discussed on preceding pages by Mr. Merrill. The object of the investigation under discussion is a study of the ability, relatively and absolutely of certain plants to appropriate phosphoric acid to their uses when presented to them in various forms, or at least when applied to the soil in various forms.

These plants have been grown in a forcing house in a manner which has been described, where it has been possible to observe them through the various stages of development, and the writer by his observations is convinced of certain facts which are not easily made clear by a display of numerical data, either in a tabular or graphic form. Even the photographic illustrations fail to show more than one or two periods of growth.

The purpose, therefore, of supplementing Mr. Merrill's clear presentation of the facts reached is to emphasize his statements by a discussion based partly on numerical data and partly upon data which may not be expressed in numbers.

It is well to remark first of all, that this investigation may be regarded from two standpoints; (1) From the plant food side, when the prominent consideration is the availability of certain materials as plant food, or (2) from the plant side, when the prominent consideration is the absolute or relative ability of different species of plants to obtain food from certain sources. We will discuss our experimental data from both points of view.

(1) The acid-rock or soluble phosphoric acid proved to be the most available.

This is true whether we base our judgment upon the early growth of the young plants or upon the total growth made. There was no instance in which the young plants fed by the soluble phosphoric acid did not show a more immediate and generous growth than when fed by the water-insoluble, and if we consider only average results, the total growth was in all cases largest from the soluble phosphoric acid though not greatly larger with certain plants. If we consider the readiness with which any material is appropriated by the very young plant as the crucial test of its availability, then the phosphoric acid used in a soluble form has a relative value greater than is indicated by the growth of the plants during a somewhat extended period of time.

The influence of the soluble phosphoric acid was in the direction of early maturity because it induced prompt early growth, but it was not true in all instances that the final growth from this form of acid was very much or even any greater than from the water-insoluble forms. The plants grown on the soluble acid certainly were the earliest plants to mature, even though they finally grew no larger than some others. This fact is one of greater importance in the production of crops out of doors during a short season, than in the forcing house where the season may be indefinitely lengthened.

(2) The water-insoluble forms of phosphoric acid were used more or less freely by all of the eight species of plants grown. This was true both with the crude Florida rock and with the phosphates of iron and alumina, although the phosphoric acid from the ground Florida rock appeared to be the more freely used in a majority of cases. While as we shall see later, this availability of the water-insoluble phosphates varied greatly with different species of plants, it was sufficient in most instances to induce a material increase of growth. It is clear, however, when we consider that nearly all of the phosphoric acid of the phosphates of iron and alumina was soluble in ammonium citrate, that in these experiments, at least, the availability of the water-soluble phosphoric acid differed greatly in degree from the citrate-soluble. The present custom of classifying the water-soluble and citrate-soluble phosphoric acid of our fertilizers together as available does not appear to be rational in the light of these experiments.

(3) The solubility of a phosphate in an ammonium citrate solution at sixty-five degrees C did not in these experiments give a correct measure of the relative availability of the phosphoric acid after application to the soil.

Two mineral phosphates were used in these experiments, one being Florida rock, containing 2.46 per cent. of phosphoric acid soluble in an ammonium citrate solution at sixty-five degrees C, the other being the so-called Redonda phosphate, consisting chiefly of hydrated phosphates of iron and alumina, which, after dehydration, contained 42.77 per cent. of phosphoric acid soluble in ammonium citrate. In the one case only seven per cent. of the phosphoric acid was soluble in the citrate solution, while in the other case eighty-six per cent. of the phosphoric acid was soluble in that liquid. If the citrate soluble phosphates are actually readily available to plants both before and after entering the soil, then the dehydrated Redonda rock should have been greatly superior to the Florida rock as a source of plant food. This did not prove to be the case, the fact being that the Florida rock proved to be the more useful. Any impartial observer who watched these experiments must have been convinced that in a majority of cases the plants were feeding more readily upon the Florida rock than upon the other material and the figures reached substantiate this conclusion. Only with the barley and corn did the

Redonda phosphate show a superior value, which, though evident, was not marked.

There are two explanations which may be suggested for this fact:

(a) The action of the citrate solution is not even an approximate measure of the root action of plants, or (b) the dehydrated phosphates of iron and alumina revert to a hydrated and less available condition after entering the soil.

(4) The eight species of plants employed in these experiments showed greatly unlike ability to appropriate phosphoric acid from the water-insoluble phosphates. The differences in this respect were striking. From almost the very earliest period of growth, the two varieties of turnips appeared to feed nearly as freely upon the Florida rock as upon the dissolved Florida rock, whereas the barley, corn, potatoes and tomatoes derived but little if any benefit from the water-insoluble phosphates until during the more advanced stages of growth, and even then the benefit was not nearly so marked as with the cruciferous plants.

The leguminous plants, viz. peas and clover, appeared to occupy a position between the cruciferous and graminaceous plants, showing a very material increase of early development due to the water-insoluble phosphates.

The facts so far observed suggest that this difference in feeding power which these plants exhibited is more than a difference between single species and relates to groups of species.

(5) The ability to appropriate water-insoluble phosphoric acid appeared with some species of plants to greatly increase as the plants developed.

While the turnips and ruta-bagas fed freely upon the crude Florida rock even in the earlier stages of growth, it was observed that not until after some weeks did the clover, tomatoes and in one case the corn, begin to make any perceptible use of the water-nsoluble phosphates.

The photographs showing the clover in two stages of growth illustrate the above statement very clearly. This observed increase of feeding power as the plants matured, so that they fed upon the crude ground rock, especially the clover, suggests that the crude ground phosphates may be made a cheap and useful source of phosphoric acid in grass fields, and on the other hand the inability of several species, notably certain of the gramineae and solanaceae, to use the water-insoluble phosphates freely in the earlier periods of growth, emphasizes the wisdom of using chiefly water-soluble phosphoric acid upon hoed crops, especially where early maturty is essential.

The following table shows very clearly the relation of growth of the several species when fed with the different forms of phosphoric acid.

TABLE III.

RELATIVE PERCENTAGE YIELD WITH THE SEVERAL FORMS OF PHOSPHORIC ACID, THE YIELD WITH NO PHOSPHORIC ACID BEING TAKEN AS 100.

		Phosphoric acid soluble in water.	Phosphoric acid in ground Florida rock.	Phosphate of iron and alumina.	No phosphoric acid.
Peas	First period	108	103	103	100
	Second period	478	248	107	100
	Third period	191	174	146	100
Turnips	First period	148	135	147	100
	Second period	325	285	234	100
	Third period	135	130	114	100
Ruta bagas	First period	117	124	134	100
	Second period	774	695	427	100
	Third period	203	174	185	100
Barley	First period	170	137	131	100
	Second period	393	102	129	100
	Third period	159	100	121	100
Corn	First period	797	372	425	100
	Second period	881	117	100	100
	Third period	429	71	104	100
Tomatoes	First period	603	533	482	100
	Second period	4549	336	128	100
	Third period	193	128	101	100

THE PROFITABLE AMOUNT OF SEED PER ACRE FOR CORN.

W. H. Jordan.

In 1894 an experiment was conducted for the purpose of testing the influence of the rate of seeding upon the growth of corn, the results being given in the Station Report for 1893, pp. 33-34. This experiment has been repeated in 1895 and the results are given below.

As in 1894 one acre of land was used. This area received a dressing of ten two-horse loads of stable manure and 750 pounds of commercial fertilizer, the latter being made up of 500 pounds acid phosphate, 100 pounds muriate of potash and 150 pounds nitrate of soda.The acre was divided into twelve plots, or four sets of plots with three plots in a set.

On one plot in each set the single kernels were planted six inches apart, on another nine inches, and on the third twelve inches. This gave four plots or one-third of an acre planted by each method.

Great pains were taken to insure a stand of stalks in accordance with the plan, and the experiment appeared to be a success so far as the field work was concerned. The intention was to allow the corn to stand only until it began to glaze and then cut it and store it in the silo. Owing to a necessary delay, the corn stood until it was too ripe for the best results as a silage crop, and while this fact does not affect the actual or comparative yield of dry matter, it accounts for the loss per cent of water in the crop as harvested. Below may be seen the composition of the corn for 1895 and the rates of yield for both years.

COMPOSITION OF CORN FROM VARYING QUANTITIES OF SEED.

	Composition of the Corn as Harvested in 1895.					
	Water—per cent.	Ash—per cent.	Protein—per cent.	Fiber—per cent.	Nitrogen free-extract—per cent.	Fats—per cent.
Kernels 6 inches apart or 6 in 3 feet ..	62.58	1.88	2.77	7.60	23.73	1.44
Kernels 9 inches apart or 4 in 3 feet ..	61.53	1.40	3.37	6.25	25.79	1.66
Kernels 12 inches apart or 3 in 3 feet ..	64.55	1.68	3.10	6.67	22.57	1.43

YIELD PER ACRE OF CORN FROM VARYING QUANTITIES OF SEED.

Crop of 1894.			Crop of 1895.		
Total yield—pounds.	Per cent dry matter.	Yield dry matter—pounds.	Total yield—pounds.	Per cent dry matter.	Yield dry matter—pounds.
21,315	21.1	4,497	16,020	37.42	5,995
22,530	20.9	4,709	15,780	38.47	6,071
20,190	20.5	4,139	15,675	35.45	5,558

The results so far reached indicate that the amount of seed may vary greatly without materially affecting the yield of dry matter in the mature crop. The average yield per acre of dry matter for the two seasons with the several rates of seeding are as follows: Kernels six inches apart 5.246 pounds; at nine inches 5.390 pounds; at twelve inches 4.848 pounds.

There appears so far to be only a small difference between six inches and nine inches seeding, whereas the yield from the twelve inches was materially smaller both years.

It should be noted, that the corn from the nine inch and twelve inch seeding was eared more satisfactorily than that from the six inch.

SUNFLOWER HEADS AND BLACKEYE PEAS AS SILAGE CROPS.

J. M. Bartlett.

In growing crops economically for this purpose two very important points must be considered.

1st. The adaptability of the crop to the process, its keeping qualities &c.

2nd. Its productiveness.

Corn is acknowledged by every one who has had much experience in the matter to be the great silage crop of this country. It is true that many other crops have been successfully kept in the silo but there is no other fodder which so uniformly produces good silage as corn.

If allowed to mature until the kernels become glazed it furnishes a valuable, succulent food for winter use, much relished by stock. It does not make, however, when fed with hay alone a properly balanced ration for milch cows. Both the grain and stalks are deficient in protein therefore it is necessary to feed with it some foods like cotton seed or linseed meal rich in protein to secure the best results.

Professor Robertson of Toronto, has suggested putting other fodders quite rich in protein with corn in the silo to make a more nearly balanced food. Horse beans and sunflower heads are the materials he uses and silage thus made has come to be called the Robertson Mixture. As a rule fodders rich in protein, like the legumes, do not keep well when put in the silo alone, but mixed with corn they are usually quite well preserved.

At the time this experiment was made, horse beans could not be obtained, consequently peas, which have about the same composition, were substituted.

It was necessary to plant them late in the season that they might not mature too early for the corn and sunflowers. The latter part of the season was unfavorable to their growth, mildew affecting them badly and consequently the yield was rather light. The sunflowers were grown on land put in the same condition as for corn, and the seed was planted one foot apart in drills three and one-half feet apart. The plants grew well and a good average yield was secured. The expense of raising the crop may be estimated to be the same as for corn.

The proportions of the different materials used for the silage was the same as for the Robertson Mixture namely: one-fourth acre sunflowers, and one-half acre of peas to one acre of corn. All were run through the cutter, packed in the silo by the ordinary method, and as is elsewhere noted, the silage kept perfectly and when opened in February was found to be in first class condition.

In the following tables will be found data giving information as to yield and composition of the crops.

TABLE IV.

YIELD PER ACRE.

	Fresh—pounds.	Air-dry—lbs.	Water-free—pounds.
Sunflower heads	12,720	2,200	2,040
Peas, whole plant	13,380	2,013	1,861

TABLE V.

COMPOSITION OF SUNFLOWER HEADS AND PEAS.

	Air Dry.						Water Free.				
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether extract.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether extract.
	%	%	%	%	%	%	%	%	%	%	%
Sunflower heads	7.27	6.73	12.63	24.4	34.56	14.41	7.26	13.62	26.30	37.27	15.55
Blackeye peas	7.57	7.45	17.19	30.00	35.18	2.61	8.06	18.60	32.47	38.04	2.83
	Fresh Plant.										
Sunflower heads	84	1.16	2.18	4.21	5.96	2.49					
Peas, whole plant	86.1	1.12	2.59	4.51	5.29	.39					

TABLE VI.

YIELD PER ACRE OF NUTRIENTS COMPARED WITH MAINE FIELD CORN AND RED CLOVER.

	Dry substance—pounds.	Protein—pounds.	Carbohydrates—pounds.	Fat—pounds.
Maine field corn	4,224	385	3,469	156
Red clover	3,400	520	3,150	133
Sunflower heads	2,040	278	1,296	317
Peas, whole plant	1,861	249	1,312	53

TABLE VII.

NUTRIENTS PER TON OF TWO THOUSAND POUNDS WATER FREE SUBSTANCE COMPARED WITH OTHER FODDERS.

	Peas—pounds.	Sunflower heads—pounds.	Red clover—pounds.	Timothy—pounds.	Mature Flint corn—pounds.	Immature Southern corn—lbs.
Protein	372.0	272.4	306	160	184	166
Carbohydrates	1,410.2	1,271.4	1,472	1,670	1,622	1,668
Fat	58.6	311.0	78	62	74	52
	1,838.8	1,854.8	1,856	1,892	1,880	1,886

Summary.

So far as is indicated by this experiment it would seem that sunflowers are not nearly as profitable a crop to raise as corn. With the same cultivation corn produces a third more protein and nearly twice as much carbohydrate material as sunflower heads.

When compared with our common red clover it will be seen that an average crop of the latter plant produces nearly twice as much protein and more carboyhydrate matter per acre. From this very limited experience we are not favorably impressed with the sunflower as a profitable silage crop. The peas are not considered, as a fair average crop was not secured.

FEEDING EXPERIMENTS WITH MILCH COWS.

J. M. Bartlett.

For the following experiments six cows known by the numbers 1, 2, 3, 4, 5 and 6 were used. All were grade Jerseys except number 4 which was a thoroughbred.

Nos. 4, 5, 6, were owned by the station and used for experimental work the previous year. Nos. 1, 2, 3, were purchased a short time before beginning the experiments. Although they were all fairly good cows their condition was not such as to make them most desirable for experimental purposes. In comparing one ration with another it is necessary to avoid heavy feeding else the differences that one kind of food might show in comparison with another might be obliterated by the excess of nutrients fed in a large ration. It is therefore essential that a grain ration near the minimum rather than the maximum limit should be employed to secure results of any value.

Cow No. 4 was rather old and had also been receiving more grain than could be used in experimental feeding, consequently she shrank rapidly in flesh and milk yield when put on the smaller ration.

Nos. 1, 2, 3, had been fed quite liberally on cotton seed meal by their previous owner and a reduction in their grain, together with the effect of transporting them 100 miles in very cold weather,caused a very material shrinkage in the milk flow. No. 1 proved to be worthless for our work as she leaked her milk quite badly, and was changed for another animal during the latter part of the first experiment.

The cows were so nearly of a size that they were all fed alike. They were weighed at the beginning and end of each period. The milk of each cow was carefully weighed at each milking and samples taken during the last five days of the periods were analyzed and the results taken as an average for the period in which they were obtained. All food given the cows was weighed as was also the water they drank.

The temperature of the stable was taken morning, noon and night.

EXPERIMENT I.

Wheat Meal Compared with Corn Meal.

It occasionally happens as was the case in the fall of 1894 that the crops in the corn raising belt are cut off through drought or other causes while those in the wheat belt are bountiful. At such

times the country is therefore deficient in its corn supply and the price of that grain advances. On the other hand wheat is plentiful and sells at a low figure. At the time this experiment was made corn was selling at ten cents more per hundred pounds than wheat meal and dealers in this section said they were selling more wheat for feed than corn, and farmers naturally were asking which was the more economical grain to feed at those prices. Chemical analysis shows wheat to be slightly richer in protein and to contain on the average less moisture than corn meal. We should therefore consider it worth more pound for pound to feed and the following data would seem to sustain that position:

THE TWO RATIONS FED DAILY.

Ration I.	Ration II.
Timothy hay, 18 pounds.	Timothy hay, 18 pounds.
Wheat meal, 5 pounds.	Corn meal, 5 pounds.
Cotton seed meal, 2 pounds.	Cotton seed meal, 2 pounds.

TABLE VIII.

COMPOSITION OF FOODS USED.

	Water—%.	Ash—%.	Protein.—%.	Fiber—%.	Nitrogen free-extract—%.	Fat—%.
Timothy hay	13.18	4.37	5.87	29.03	45.08	2.47
Wheat meal	9.29	2.10	12.81	2.62	71.06	2.12
Corn meal	14.98	1.42	9.17	1.90	68.76	3.77
Cotton seed meal	8.17	7.17	42.31	5.62	23.65	13.08

TABLE IX.

FOOD CONSUMED BY EACH COW FOR EACH PERIOD OF TWENTY-ONE DAYS.

Period I.	Period II.	Period III.
Timothy hay 348 lbs	Timothy hay 348 lbs	Timothy hay 348 lbs.
Wheat meal 105 lbs	Corn meal 105 lbs	Wheat meal 105 lbs.
Cotton seed meal 42 lbs	Cotton seed meal 42 lbs	Cotton seed meal 42 lbs.

TABLE X.

*DIGESTIBLE NUTRIENTS CONSUMED BY EACH COW.

Period I.		Period II.		Period III.	
	Pounds.		Pounds.		Pounds.
Protein	37.51	Protein	32.29	Protein	37.51
Carbohydrates	237.57	Carbohydrates	237.35	Carbohydrates	237.57
Fat	12.55	Fat	14.19	Fats	12.55
Total	287.63	Total	283.83	Total	287.63
Nutritive ratio 1 to 7.09.		Nutritive ratio 1 to 8.7.		Nutritive ratio 1 to 7.09.	

* American coefficients were used—those given for wheat middlings were used for the wheat meal.

TABLE XI.

WATER DRANK DAILY (POUNDS).

Number of Cow.	1	2	3	4	6
First period	57	60	68	58	57
Second period	64	65	77	59	57
Third period	-	70	81	60	60

TABLE XII.

COMPOSITION OF MILK FOR LAST FIVE DAYS OF EACH PERIOD.

	Cow 1.		Cow 2.		Cow 3.		Cow 4.		Cow 6.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
	%	%	%	%	%	%	%	%	%	%
January 11	13.39	4.35	13.82	4.60	12.26	3.60	12.90	4.60	14.98	5.20
January 12	13.48	4.45	13.84	4.55	12.42	3.75	12.63	3.95	14.55	4.75
January 13	13.34	4.30	13.69	4.40	12.20	3.45	12.62	4.05	14.48	5.00
January 14	13.42	4.20	13.80	4.60	12.88	4.10	13.04	4.70	15.09	5.10
January 15	13.73	4.40	13.81	4.40	12.87	3.90	13.05	4.60	15.18	5.35
Average	13.47	4.34	13.79	4.51	12.52	3.76	12.85	4.38	14.85	5.08
February 1	13.52	4.15	14.33	4.75	12.88	3.80	13.78	4.85	15.19	5.15
February 2	13.36	4.30	13.94	4.65	12.74	4.10	13.28	4.40	14.95	5.30
February 3	13.71	4.70	14.02	4.80	12.75	3.07	13.09	4.40	15.25	5.45
February 4	13.62	4.60	14.39	4.95	12.71	3.80	13.32	4.30	15.40	5.40
February 5	13.23	4.20	13.89	4.15	13.01	4.10	13.86	4.90	15.10	5.15
Average	13.49	4.39	14.11	4.66	12.82	3.77	13.47	4.57	15.18	4.29
February 22	.....	.....	14.36	4.85	13.35	4.10	13.94	5.00	15.21	5.30
February 23	.....	.....	14.63	4.20	13.32	4.40	14.34	5.15	15.81	5.55
February 24	.....	.....	14.32	5.00	13.46	4.35	14.50	5.45	15.68	5.55
February 25	.....	.....	14.65	5.20	13.61	4.50	14.48	5.65	16.05	5.75
February 26	.....	.....	14.54	5.20	12.77	4.00	14.36	5.40	15.02	5.30
Average	.....	.....	14.50	4.89	13.30	4.27	14.32	5.33	15.55	5.49

TABLE XIII.

MILK YIELD PER WEEK IN POUNDS, AND AVERAGE TEMPERATURE OF STABLE.

December 26 to January 15.	Temperature—Fahrenheit.	Number of Cows.				
		1.	2.	3.	4.	6.
First week	.....	114	147.8	156.5	143.6	125.6
Second week	41	104.3	147	155	126.6	115.1
Third week	47	112.8	142.5	159	119.3	119.9
January 16 to February 5.						
First week	45	105.3	141.3	153.9	114.8	121.1
Second week	44	106.1	139.1	152.7	114.3	120
Third week	41	100.8	140.6	148.9	111.7	118.5
February 6 to February 26.						
First week	38	.....	132.7	140.6	101.5	113.9
Second week	49	.....	127.5	141.3	98.7	114.6
Third week	44	.....	126.0	134.6	87.3	111.4

TABLE XIV.

WEIGHT OF COWS. WEIGHT GAINED. WEIGHT LOST. MILK, SOLIDS AND FAT PRODUCED BY EACH COW (POUNDS.)

	Cow.	Weight.	Weight gained.	Weight lost.	Milk.	Solids.	Fat.
	1	830	5	.....	336	45.26	14.58
PERIOD I.	2	930	15	.....	437.37	60.32	19.73
(Wheat meal.)	3	880	.....	5	469.37	58.77	17.65
21 days.	4	830	.....	15	389.50	50.17	17.05
	6	859	8	.....	360.75	53.58	18.32
Total	.....	.....	28	20	1,992.99	268.10	87.33
Total omitting I	.....	.....	.....	.....	1,656.99	222.84	72.75
Daily yield	.....	.....	.....	.....	19.73	2.65	.87
	1	835	.....	18	322.25	43.54	14.15
PERIOD II.	2	945	.....	30	421.00	59.40	19.62
(Corn meal.)	3	875	.....	20	455.37	58.11	17.09
21 days.	4	815	.....	6	340.87	45.88	15.58
	6	867	.....	2	359.62	54.57	19.02
Total	.....	.....	.....	76	1,899.11	261.50	85.46
Total omitting I	.....	.....	.....	.....	1,576.86	217.96	71.31
Daily yield	.....	.....	.....	.....	18.78	2.60	.85
PERIOD III.	2	915	10	.....	386.25	55.99	18.88
(Wheat meal.)	3	855	5	.....	416.50	55.39	17.78
21 days.	4	804	.....	19	287.50	41.17	15.32
	6	865	10	.....	339.75	52.84	18.66
Total	.....	.....	25	19	1,430.00	205.39	70.44
Daily	.....	.....	.....	.....	17.03	2.45	.84

Conclusions drawn from the foregoing data.

1st. Wheat meal pound for pound furnishes more food than corn meal, noticeably more digestible protein. Table X.

2nd. When wheat can be bought at about the same price as corn it is a more economical grain to buy.

3rd. It is more valuable than corn to feed with hay or such grains as barley and oats because richer in protein.

4th. When fed to milch cows in the proportions given in this experiment it produced as much milk and greater gain in flesh, as

shown in Table XIV. It is very noticeable that the rations fed in Period I and III were more efficient than that fed in Period II. While there was a very gradual and uniform shrinkage in milk solids through all the periods, due to the advance in time of lactation, the fact that the cows all lost weight in Period II and gained again, with the exception of No. 4, in Period III, furnishes good grounds for the above statement.

EXPERIMENT II.

Ensilage composed of mature flint corn, sunflower heads and peas as food for milch cows.

When this experiment was planned it was the intention to use the so called Robertson Mixture of corn, sunflower heads and horse beans, but as no horse beans could be procured in time for planting, Blackeyed peas were substituted. The peas were sown quite late that they might not mature too early for the corn and sunflowers. The materials were all harvested and put in the silo at the proper stage of maturity, the latter part of September. The last of February the silo was opened and the silage found to be in most excellent condition, being perfectly preserved and when fed was much relished by the stock.

The object of making the mixture was to secure a more nearly balanced ration than is furnished by corn alone. The peas were added to increase the protein and the sunflower heads the protein and fat, the seeds being very rich in oil.

Every farmer is well aware of the great efficiency of a pasture grass ration, and if we can therefore produce a succulent food for winter use that will approach approximately the composition and digestibiltiy of pasture grass, we shall be able in part to substitute it for the grain now fed and thereby save something of the enormous outlay expended by farmers for that purpose.

It is perhaps true that just at the present time protein can be more cheaply purchased in cotton seed meal than it can be produced on an Eastern farm, but the time is not far distant when we may expect to see that most excellent food very materially advance in price. The Southern and Western farmers are beginning already to appreciate its value and are feeding large quantities to stock, and we have every reason to believe that this practice will increase with the constantly growing dairy interests of those regions.

The details of the experiment are given in the following tables.

It will be noticed that the grain ration fed the first Period was light but was thought to be sufficient with the amount of ensilage used and just the reason why in the first period some of the cows should lose in weight and maintain their milk flow and then gain in weight and lose in milk flow during the second period, is not apparent unless the changes were due to variation in the stomach and intestinal contents at the times of weighing rather than any actual gain or loss in flesh.

TABLE XV.

	Fine hay—pounds.	Corn meal—pounds.	Cotton seed meal—pounds.	Bran—pounds.	Ensilage—pounds.
Ration I	10	3	1 1-2	1 1-2	30
Ration II	10 4-7	....	...	.....	50
Ration III	10	1-2	3-4	3-4	50

TABLE XVI.

FOOD CONSUMED BY THE FIVE COWS IN EACH PERIOD.

Period I.		Period II.		Period III.		Period IV.		Period V.	
	Pounds.		Pounds.		Pounds.		Pounds.		Pounds.
Hay	700	Hay	740	Hay	700	Hay	700	Hay	700
Silage	2,100	Silage	3,500	Silage	2,100	Silage	3,500	Silage	2,100
Corn meal,	210	.....		Corn meal,	210	Corn meal	105	Corn meal	210
C. S. meal	105	.....		C. S. meal	105	C. S. meal,	52½	C. S. meal,	105
Bran	105	.....		Bran	105	Bran	52½	Bran	105

TABLE XVII.

COMPOSITION OF FOODS USED.

	Water—per cent.	Ash—per cent.	Protein—per cent.	Fiber—per cent.	Nitrogen free extract—per cent.	Fats—per cent.
Hay—bluegrass	5.10	4.92	6.81	30.00	49.78	3.39
Corn meal	14.98	1.42	9.17	1.90	68.76	3.77
Cotton seed meal	8.17	7.17	42.31	5.62	23.68	13.08
Bran	11.91	5.78	15.42	8.99	53.87	4.03
Silage	76.31	1.81	2.89	5.56	12.17	1.26

TABLE XVIII.

TOTAL AND DIGESTIBLE NUTRIENTS CONSUMED BY EACH COW FOR EACH PERIOD.

	Period I. Pounds.	Period II. Pounds.	Period III. Pounds.	Period IV. Pounds.	Period V. Pounds.
(Total.)					
Protein	37.65	30.28	37.65	37.72	36.32
Carbohydrates	237.22	242.34	237.22	261.32	229.31
Fat	14.20	13.80	14.20	16.13	13.91
Total organic matter	289.07	286.42	289.07	315.17	279.54
Eaten daily	20.6	20.4	20.6	22.5	19.9
(Digestible.)					
Protein	26.17	18.80	26.17	24.92	24.39
Carbohydrates	165.40	166.87	165.40	183.46	157.95
Fat	11.80	10.79	11.80	12.05	11.39
Total organic matter	203.37	196.46	203.37	220.43	193.73
Eaten daily	14.5	14.0	14.5	15.7	13.8
Nutritive ratio	1 to 7.33	1 to 10.02	1 to 7.33	1 to 8.45	1 to 7.53

TABLE XIX.

AVERAGE AMOUNT OF WATER DRANK DAILY BY EACH COW.

	1. Pounds.	2. Pounds.	3. Pounds.	5. Pounds.	6. Pounds.
Period I	35	38	48	29	37
Period II	26	38	46	37	35
Period III	36	47	61	48	44
Period IV	43	49	62	47	47
Period V	44	49	61	47	4

TABLE XX.

AVERAGE COMPOSITION OF MILK FOR LAST FIVE DAYS OF EACH PERIOD.

Cows.	1.		2.		3.		5.		6.	
	Solids—%.	Fat—%.	Solids—%.	Fat—%.	Solids—%.	Fat—%.	Solids—%.	Fat—%.	Solids—%.	Fat—%.
Period I	13.78	4.33	14.18	5.04	12.87	4.13	12.57	4.07	14.80	5.27
Period II	13.50	4.26	13.77	4.78	12.42	3.98	12.38	3.67	15.04	5.42
Period III	13.36	4.19	14.25	4.97	12.99	3.97	12.29	4.07	14.39	4.84
Period IV	13.81	4.31	14.36	4.81	13.19	3.94	12.74	4.07	14.33	5.05
Period V	13.81	4.44	14.77	5.04	13.87	4.39	12.88	4.25	13.95	4.74

TABLE XXI.

TEMPERATURE OF STABLE AND YIELD OF MILK FOR EACH COW PER WEEK.

	Temperature of stable—Fahrenheit.	Milk Produced by Cows.				
		1. Lbs.	2. Lbs.	3. Lbs.	5. Lbs.	6. Lbs.
March 16 to March 29.						
First week	45°	97.8	102.9	137.7	159.4	123.1
Second week	50°	102.5	107.4	136.1	151.6	124.4
March 30 to April 12.						
First week	50°	91.3	92.4	121.3	135.6	121.6
Second week	52°	88.3	90.8	113.0	131.5	108.3
April 13 to April 27.						
First week	54°	86.8	94.3	119.0	143.8	125.1
Second week	58°	101.0	106.0	123.6	145.9	139.9
May 4 to May 17.						
First week	70°	100.9	97.0	110.9	140.8	133.6
Second week	63°	102 3	104.6	113.3	141.3	137.3
May 18 to May 31.						
First week	58°	101.9	98.9	102.9	138.1	130.9
Second week	65°	105.3	101.5	94.8	135.6	145.6

TABLE XXII.

WEIGHT OF COWS—GAIN AND LOSS IN WEIGHT—POUNDS OF MILK, SOLIDS AND FAT PRODUCED BY EACH COW FOR EACH PERIOD.

	Number cow.	Weight of cow—pounds.	Gain in weight—pounds.	Loss in weight—pounds.	Milk—pounds.	Solids—pounds.	Fat—pounds.
Period I. 14 days.	1	922	4	.....	200.3	27.6	8.67
	2	923	.....	23	210.1	29.8	10.60
	3	857	.....	14	273.8	35.3	11.34
	5	708	7	.....	311.0	39.1	12.66
	6	875	.....	7	247.5	36.6	13.05
Total	.....	.....	11	44	1,242.7	168.4	56.32
Daily yield	.....	.....	.....	.....	17.8	2.41	.81
Period II. 14 days.	1	926	.....	3	179.5	24.9	7.65
	2	896	22	.....	183.4	25.2	8.76
	3	843	9	.....	234.3	29.1	9.32
	5	715	2	.....	267.1	33.1	9.80
	6	868	.....	15	229.9	32.7	12.45
Total	.....	.....	33	18	1,094.2	145.0	47.98
Daily yield	.....	.....	.....	.....	15.6	2.07	.685
Period III. 14 days.	1	923	15	.....	187.8	25.1	7.87
	2	918	7	.....	200.3	28.00	9.55
	3	852	.....	12	242.6	31.50	9.63
	5	717	3	.....	289.6	36.9	11.80
	6	853	.....	8	265.0	38.1	12.83
Total	.....	.....	25	20	1,185.3	159.6	51.64
Daily yield	.....	.....	.....	.....	17.0	2.28	.74
Period IV. 14 days.	1	938	10	.....	203.2	28.1	8.77
	2	925	3	.....	201.6	29.0	9.70
	3	840	14	.....	224.1	29.6	8.82
	5	720	2	.....	282.0	35.9	11.48
	6	845	12	.....	270.9	38.8	13.70
Total	.....	.....	41	.....	1,181.8	161.4	52.47
Daily yield	.....	.....	.....	.....	16.9	2.36	.75
Period V. 14 days.	1	952	12	.....	207.1	28.6	9.20
	2	929	13	.....	200.4	29.6	10.10
	3	860	5	.....	197.6	27.4	8.68
	5	723	.....	16	273.8	35.3	11.60
	6	862	23	.....	276.6	38.6	13.10
Total	.....	.....	53	16	1,155.5	159.5	52.68
Daily yield	.....	.....	.....	.....	16.5	228.0	.75

TABLE XXIII.

TOTAL AND DIGESTIBLE NUTRIENTS EATEN FOR EVERY POUND OF MILK, SOLIDS, AND FAT PRODUCED.

	Period I—lbs.	Period II—lbs.	Period III—lbs.	Period IV—lbs.	Period V—lbs.
(Total Nutrients.)					
Milk	1.15	1.31	1.22	1.13	1.21
Solids	8.53	9.87	9.05	9.78	9.44
Fat	25.5	29.8	27.98	30.04	28.6
(Digestible Nutrients.)					
Milk	.82	.90	.86	.93	.84
Solids	6.04	6.77	6.37	6.83	6.07
Fat	18.10	20.50	19.70	21.02	18.40

From the data presented in the preceding tables we are warranted in making the following summary.

1st. That the materials composing the silage used can be perfectly preserved and successfully kept in the silo as late as June of the following year.

2nd. That the pea, sunflower and corn mixture produces a silage somewhat richer in protein than corn alone and is very greedily eaten by stock.

3rd. That to attempt to substitute this mixture entirely for the grain ration was not a success as shown by Table XXII, the cows shrinkng quite materially in their flow of milk without an increase in its richness. The shrinkage was undoubtedly due to a lack of digestible protein as will be seen by consulting Table XVIII; the total and digestible organic matter consumed was practically the same but the protein was considerably less than in Period I. On returning to the grain and silage ration in Period III the flow of milk was increased to nearly the original yield.

4th. In Period IV silage was substituted for one-half the grain ration, twenty pounds silage for three pounds grain, with good results. All the cows increased in weight and shrank no more in milk than would be expected from the advance in time of lactation, the solids and fat increasing slightly.

THE RELATION OF FOOD TO THE GROWTH AND COMPOSITION OF THE BODIES OF STEERS.*

W. H. Jordan.

General Considerations.

The problems pertaining to animal nutrition are among the most difficult of solution of any that confront the investigator. This is due largely to the fact that many of the phenomena, chemical and physical, which occur in the animal organism and that are involved in the processes of growth, are hidden from the ordinary means of observation. An animal eats, digests and assimilates food and as a result uses energy and forms tissues of various kinds. We know that in some way the food supplies the materials for growth,but such questions as the nutritive office of the single compounds of the food and the effect upon the animal of varying these compounds in their relative quantities, are so far partially answered. Such information as we do possess along these lines has been obtained partly by circumstantial rather than by direct evidence, and many conclusions have been inferential in their nature and are not the outcome of direct testimony. Only investigations long continued and of the most searching kind are competent to reveal the nature and extent of the chemical and physical changes in the animal body. The ordinary practical feeding experiments, while they may furnish guides for practice, explain none of these troublesome problems. If one animal increases in weight more rapidly on one food mixture than another animal does on a widely different ration we simply know the fact. The explanation of the fact we may infer with a fair chance of a wrong inference in some cases. First of all we are not sure that the actual growth is proportional to the increase in weight, although where the experiment covers a long period of time it is reasonable to assume that such is the case. Again, granting that great differences in actual growth of tissue actualy exist, we cannot now fully explain, perhaps never can, in what way the food is responsible for these differences. The need of fuller knowledge concerning the fundamental facts of digestion and metabolism is a

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* Analyses performed by J. M. Bartlett and L. H. Merrill,—the animals in care of A. M. Shaw.

pressing one and the investigator who is using the respiration apparatus and other scientific facilities in a search for this knowledge has before him great possibilities for valuable service. But this lack of knowledge does not constitute a reason why observations of a practical character should not be continued. Feeding experiments may convince us of certain facts which science shall sometime explain. We should demand, however, that the conclusions derived from these experiments shall be fortified by all the accurate data which it is possible to secure, and so in studying the relation of food to growth, it is essential to know not only the amount and kind of nutrients supplied to the animals but also the extent and character of the growth produced.

The Problem Studied.

There is much discussion at the present time, of the relative influence and economy of various food combinations. "Standard rations," "narrow ratio" and "wide ratio" are familiar phrases, all of which have to do with a wide spread conviction that the manner in which foods of different classes are combined has much to do with the character of the product and the profit of feeding animals.

It is generally taught that a given amount of digestible food should have not less than a certain proportion of protein in order that it may cause a maximum production, and scientific data, practical feeding experiments and even common experience appear to warrant such teaching. It is claimed, still further, that not only the amount but the kind of product is to an extent under the control of the food, and the experiments of Sanborn, Henry, Roberts and Georgeson with swine, lambs and steers appear to substantiate this claim, certainly so far as it relates to swine.

In all these experiments the evidence of the effect of the food in modifying the composition of the carcass is simply the apparent relative amount of the fat and lean tissues, save in certain instances where a chemical analysis was made of a portion of the carcasses, too small to furnish reliable data. With the swine in some cases the differences in the carcasses in their proportions of lean and fat were too unmistakable to allow an erroneous judgment, but with the sheep and steers no past experiments seem to have been so conducted as to prove that the rations differed in effect other than to cause more growth or less growth. Moreover, the experiments with ruminants for the purpose of studying the effect of food upon the kind of growth were not begun with the young animals and continued until they reached a somewhat mature growth, but covered only such periods of time as would be required to fatten the animals for the market.

The experiment which is detailed in the following pages had for its object a study of the effect of widely different rations upon the rate of growth and composition of the bodies of steers, and it is

believed in that two particulars it is a distinct improvement upon similar experiments previously conducted: (1) The feeding was begun with the animals as calves and continued from seventeen to twenty-seven months or until the steers had attained a size from 870 to 1300 pounds. (2) The bodies of the animals, excepting the skins, were entirely submitted to chemical analysis.

Plan of the Experiment.

Character of the steers. Four steer calves were purchased in the summer of 1893 of R. & C. D. Waugh, Starks, Me., and they reached the station on June 7th. Their breeding is described in the following extract from a letter from the Messrs. Waugh. "The men that raised the calves have kept thoroughbred Durham bulls for over forty years, and they are high grades."

The calves were therefore not full blooded animals but were high Shorthorn grades, and were quite uniform in quality. One pair was two or more months older than the other two, and in dividing the animals into two lots one older and one younger animal were assigned to each lot. At the time when the experimental feeding began the age of the calves ranged from five to seven months.

The rations. The steers were fed alike until the last week of August, 1893, at which time the feeding of the experimental rations begun. On September 1st, the animals were weighed for the first time and from that date a record of the daily rations and weekly changes in live weight was kept until the end of the experiment.

The grain rations consisted of mixed grains with both lots. At first Steers 1 and 2 were fed a mixture consisting of one part linseed meal one part corn meal and one part wheat bran, by weight. This mixture was continued until January 22, 1894, when it was changed to one consisting of two parts linseed meal, one part corn meal and one part wheat bran, which was continued throughout the remainder of the experiment. Steers 3 and 4 were fed during the entire experiment on a grain mixture consisting of two parts corn meal and one part wheat bran, by weight.

The coarse food consisted entirely of hay, except in the winter 1893-4 when corn fodder and corn silage were also fed. At no time was the daily ration what would be considered heavy feeding. The object of the experiment was to discover the specific effect of quite different rations rather than to produce the largest possible animals within a given time, and to this end the rations were restricted to a moderate quantity, on the ground that less vicissitudes would attend the experiment and that any thing approaching an excess of food would tend to obscure the influence of a more or less favorable combination of nutrients.

At the beginning, the daily ration was five pounds of hay or its equivalent and one pound of mixed grain, and the largest ration

fed to any steer during the entire experiment was thirteen pounds of hay and eight pounds of grain. Considering the small amount of food eaten, the growth of the animals was very satisfactory.

As can be readily seen, neither of the rations fed can be considered as unusual. Neither one is unlike what might be found in the practice of many cattle feeders. Neither one includes extraordinary materials or proportions of nutrients. The one was compounded to a nutritive ratio not unlike the German standard rations for growing animals, and the other was made up so as to represent what is called a "wide ration." Both rations were consistent with health and a normal development of the animals and doubtless both would be included within the limits of good practice, if these limits are to be bounded by the extremes of opinion among practical feeders.

The essential difference between the two rations lies in the marked difference in the proportions of protein which they contained, and the discussion of results centers around this fact. Certainly it cannot be claimed in either case that there was a deficiency of bone making material or that any other especially abnormal condition prevailed.

The manner of the experiment. Throughout the entire time the steers were stall fed, mostly, as previously stated, upon dry food. During all seasons they were allowed exercise in a large yard, excepting during rain storms or the severest winter days. The food was weighed out daily and the animals were weighed on three consecutive days of each week, the averages of these three weighings being taken as the actual weights. The grains were not weighed out separately on each day, but were mixed in large quantities, the total daily ration being obtained by a single weighing. Each new mixture of grains was sampled and the samples were submitted to chemical analysis. Analyses were also made of the corn fodder and silage eaten, but not of the hay.

It is a matter for congratulation that the experiment progressed in an unusually satisfactory manner. The animals were continuously in good health and no accidents or disturbances of any kind occurred to mar the success of the work, which, considering that the experiment covered more than two years time, must be regarded as a piece of good fortune.

In January and February 1895 two animals, one from each lot, Nos. 1 and 4, were killed and analyzed. These steers had been fed experimentally about seventeen months and weighed 958 and 870 pounds respectively. The other two animals, Nos. 2 and 3 were fed for more than ten months longer or until during December 1895 and weighed when slaughtered 1300 and 1280 pounds. These latter animals had been fed therefore over twenty-seven months.

As the animals were slaughtered, the blood, the various organs and the carcasses were weighed and all these parts were immediately

prepared for analysis, the main object of the experiment being to determine the actual quantities of ash, protein and fats that had been produced in the bodies of the several steers.

The food. The grains were purchased in the Bangor market. The hay fed was mostly timothy and was nearly all raised on the College Farm. The corn fodder and silage were also from corn produced by the experiment station in 1893.

The composition and digestibility of the foods. As before stated the grains were mixed in large lots and samples were taken for analysis. No analyses were made of the particular hay eaten, but it is assumed to have a composition similar to the average composition of the hay produced on the College Farm during five previous seasons.*

The corn fodder and silage are assumed to have the same composition as the entire lots of southern corn and field corn for the year 1893.**

Table XXIV shows the composition of various foods.

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* See Report Maine Experiment Station, 1889, p. 39.

** See Report Maine Experiment Station, 1893, p. 27.

TABLE XXIV.

COMPOSITION OF THE FOODS.

	Composition as Fed.					
	Water.	Ash.	Protein.	Fiber.	Nitrogen free-extract.	Fats.
	%	%	%	%	%	%
Hay (assumed)	13.0	4.12	6.76	28.55	44.66	2.91
Southern corn fodder (or silage)	84.0	1.2	1.8	4.4	8.2	.4
Field corn fodder (or silage)	80.5	1.2	2.4	4.1	11.3	.5
Mixed grains, fed steers 1 and 2:						
Lot mixed August 25, 1893	11.34	3.98	19.37	6.07	53.51	5.73
December 20, 1893	11.25	4.28	21.43	6.71	51.16	5.17
January 22, 1894	11.32	4.55	25.18	7.48	45.93	5.54
February 23, 1894	10.90	4.87	24.62	7.77	46.70	5.14
April 4, 1894	10.95	4.81	25.18	7.19	46.84	5.03
June 16, 1894	10.56	4.52	26.06	7.02	48.35	3.49
August 22, 1894	9.88	4.61	25.94	7.25	48.38	3.94
October 20, 1894	9.84	4.29	25.35	7.11	48.97	4.44
December 31, 1894	12.54	4.10	24.19	7.49	48.58	3.10
February 4, 1895	14.15	4.19	23.44	7.38	48.32	2.52
April 30, 1895	11.67	4.17	27.44	7.37	47.15	2.20
June 11, 1895	10.76	4.18	26.62	7.21	47.79	3.44
Average	11.2	4.4	24.6	7.2	48.5	4.1
Mixed grains, fed steers 3 and 4:						
Lot mixed August 25, 1893	12.79	3.20	11.75	3.84	63.73	4.69
December 20, 1893	12.39	2.70	11.90	4.42	64.34	4.25
February 23, 1893	11.94	3.39	11.50	4.71	64.01	4.45
April 4, 1893	11.65	3.35	12.68	4.87	62.80	4.65
June 16, 1893	11.02	3.30	11.87	4.62	66.43	2.76
August 22, 1893	10.47	2.91	12.25	4.26	65.44	4.67
October 20, 1893	10.34	2.50	12.06	3.91	66.91	4.28
Average	11.5	3.1	12.00	4.4	64.8	4.2

The digestion coefficients used are stated below and are the averages of German and American results in the case of the corn meal and linseed meal, and the American averages alone for the bran, hay and silage. The coefficients for the mixtures are calculated from the coefficients of the single grains.

TABLE XXV.

	Digestion Coefficients.			
	Protein.	Fiber.	Carbo-hydrates.	Fats.
Hay—average for Timothy, all kinds	49	53	63	57
Corn fodder and silage, field corn	63	75	77	83
Southern corn	49	71	66	75
Grain mixture, Steers 1 and 2	80	50	78	85
Steers 3 and 4	73	47	85	82

EFFECT OF THE TWO RATIONS UPON THE INCREASE OF LIVE WEIGHT.

The grain mixtures which the steers received were in the following proportions:

Steers 1 and 2.	Steers 3 and 4.
Linseed meal, 2 parts.	Corn meal, 2 parts.
Corn meal, 1 part.	Wheat bran, 1 part.
Wheat bran, 1 part,	

The coarse foods consisted of hay, with more or less silage during the first winter.

The quantities of grain fed daily were alike for all steers, excepting slight differences during the first few weeks. The amounts of coarse foods eaten daily differed somewhat with the several animals being least for Steer 1, most for Steer 2 and alike for steers 3 and 4.

From the preceding data have been calculated the quantities of food and amounts of dry and digestible material consumed by the several steers.

This has been done not only for the entire time that the steers were fed, but also for the first fifteen months in periods of three months each. There is shown also the nutritive ratios of the rations and the relations between food consumed and the gain in live weight.

The tables which immediately follow are as follows:

Table XXVI to XXIX. The foods eaten and gains of live weight by periods of four to six weeks for the entire experiment.

Table XXX. Summary of Tables 1 to 4.

Table XXXI. Dry matter and digestible matter eaten by the four steers during the entire experiment, with relation of food to growth.

Table XXXII. Summary of Table VI.

Table XXXIII. Dry and digestible matter eaten by the four steers during the first fifteen months of the experiment, considered in five periods, with relation of food to growth.

Table XXXIV. Daily food consumption and growth of steers during first fifteen months of the experiment, considered in five periods.

TABLE XXVI.

FOODS EATEN AND GAINS OF LIVE WEIGHT.—ENTIRE EXPERIMENT.

STEER 1.

Dates.	No. of days.	Food Eaten.			Weight.		
		Hay—pounds.	Silage or corn fodder—pounds.	Grain mixture—pounds.	Initial—pounds.	End—lbs.	Grain—pounds.
1893, September 1—28	28	... ..	*616	31.5	221	257	36
September 28—October 26	28	109	*214	45.5	257	279	22
October 26—November 30	35	228	.....	81.5	279	327	48
November 30—December 28	28	196	.....	82	327	363	36
December 28—January 25	28	136	†300	98	363	397	34
1894, January 25—February 22	28	56	†700	111	397	447	50
February 22—March 29	35	70	‡875	140	447	514	67
March 29—April 26	28	56	‡608	112	514	544	30
April 26—May 31	35	148	†860	140	544	630	86
May 31—June 28	28	280	.....	112	630	681	51
June 28—July 26	28	280	.....	112	681	707	26
July 26—September 6	42	420	....	193	707	758	51
September 6—October 4	28	280	.....	140	758	803	45
October 4—November 1	28	280	.....	144	803	851	48
November 1—December 6	35	350	.....	249	851	903	52
December 6—January 3	28	280	.....	224	903	935	32
1895, January 3—January 28	24½	245	.....	196	935	958	23
Totals	514.5	3,414	4,173	2,211	.....	.....	737

* Field corn. † Southern corn silage. ‡ Field corn silage.

TABLE XXVII.

FOOD EATEN AND GAINS OF LIVE WEIGHT—ENTIRE EXPERIMENT.

STEER 2.

Dates.	No. of days.	Food Eaten.			Weights.		
		Hay—lbs.	Corn fodder or silage—pounds.	Mixed grains—pounds.	Initial—pounds.	End—lbs.	Gain—lbs.
1893, September 1—28	28	.....	*963	29.5	345	398	53
September 28—October 26	28	147	*315	43.5	398	424	26
October 26—November 30	35	280	.....	81.5	424	451	27
November 30—December 28	28	224	.....	61	451	482	31
December 28—January 25	28	161	†300	98	482	512	30
1894, January 25—February 22	28	84	†700	111	512	563	51
February 22—March 29	35	105	‡875	140	563	625	62
March 29—April 26	28	88	‡700	112	625	675	50
April 26—May 31	35	183	†875	140	675	749	74
May 31—June 28	28	308	.....	112	749	782	33
June 28—July 26	28	308	.....	112	782	812	30
July 26—September 6	42	462	.....	193	812	860	48
September 6—October 4	28	308	.....	140	860	897	37
October 4—November 1	28	308	.....	144	897	920	23
November 1—December 6	35	385	.....	249	920	958	38
December 6—January 3	28	308	.....	224	958	987	29
1895, January 3—January 31	28	308	.....	224	987	1,023	36
January 31—February 28	28	308	.....	224	1,023	1,040	17
February 28—March 28	28	308	.....	224	1,040	1,075	35
March 28—April 25	28	308	.....	224	1,075	1,105	30
April 25—May 30	35	385	.....	280	1,105	1,140	35
May 30—June 27	28	308	.....	224	1,140	1,158	18
June 27—August 1	35	385	.....	280	1,158	1,185	27
August 1—August 29	28	308	.....	224	1,185	1,223	38
August 29—September 26	28	369	.....	224	1,223	1,255	32
September 26—October 31	35	455	.....	280	1,255	1,268	13
October 31—November 28	28	364	.....	224	1,268	1,307	39
November 28—December 23	24½	318½	.....	196	1,307	1,300	—7
Totals	843.5	7783.5	4,728	4,818.5	.....	.....	969

* Field corn. † Southern corn silage. ‡ Field corn silage.

TABLE XXVIII.

FOODS EATEN AND GAINS OF LIVE WEIGHT—ENTIRE EXPERIMENT.

STEER 3.

Dates.	No. of days.	Food Eaten.			Weights.		
		Hay—lbs.	Corn fodder or silage—pounds.	Grain mixture—pounds.	Initial—pounds.	End—lbs.	Gain—pounds.
1893, September 1—September 28	28	.. ..	*782	29	285	309	24
September 28—October 26	28	128	*261.5	45.5	309	331	22
October 26—November 30	35	245	.....	81.5	331	361	30
November 30—December 28	28	196	....	82	361	389	28
December 28—January 25	28	136	†300	98	389	410	21
1894, January 25—February 22	28	56	†700	111	410	453	43
February 22—March 29	35	70	‡875	140	453	509	56
March 29—April 26	28	56	‡700	112	509	559	50
April 26—May 31	35	148	†875	140	559	621	62
May 31—June 28	28	280	.....	112	621	661	40
June 28—July 26	28	280	.....	112	661	701	40
July 26—September 6	42	420	.....	193	701	750	49
September 6—October 4	28	280	.....	140	750	780	30
October 4—November 1	28	280	....	144	780	801	21
November 1—December 6	35	350	....	249	801	862	61
December 6—January 3	28	280	.....	224	862	875	13
1895, January 3—January 31	28	280	.....	224	875	913	38
January 31—February 28	28	280	....	224	913	950	37
February 28—March 28	28	280	....	224	950	994	44
March 28—April 25	28	280	.....	224	994	1,036	42
April 25—May 30	35	350	.....	280	1,036	1,080	44
May 30—June 27	28	280	.....	224	1,080	1,114	34
June 27—August 1	35	350	... .	280	1,114	1,127	13
August 1—August 29	28	280	.....	224	1,127	1,163	36
August 29—September 26	28	332	... .	224	1,163	1,208	45
September 26—October 31	35	420	....	280	1,208	1,248	40
October 31—November 28	28	336	.....	224	1,248	1,290	42
November 28—December 10	11½	138	.....	92	1,290	1,280	10
Totals	833.5	6,811	4,493.55	4,737	.....	.....	1,015

* Field corn. † Southern corn silage. ‡ Field corn silage.

TABLE XXIX.

FOODS EATEN AND GAINS OF LIVE WEIGHT—ENTIRE EXPERIMENT.

STEER 4.

Dates.	No. of days.	Food Eaten.			Weights.		
		Hay—lbs.	Fodder or silage—pounds.	Mixed grains—pounds.	Initial—pounds.	End—pounds.	Gain—pounds.
1893, September 1—September 28	28	.....	*763	29.5	318	338	20
September 28—October 26	28	128	*256	35.5	338	366	38
October 26—November 30	35	245	.....	81.5	366	385	19
November 30—December 28	28	196	.....	82	385	401	16
December 28—January 25	28	136	†300	98	401	424	23
1894, January 25—February 22	28	56	†700	111	424	468	44
February 22—March 29	35	70	‡875	140	468	525	57
March 29—April 26	28	56	‡700	112	525	573	48
April 26—May 31	35	148	†875	140	573	628	55
May 31—June 28	28	280	.....	112	628	680	52
June 28—July 26	28	280	.....	112	680	702	22
July 26—September 6	42	420	.....	193	702	725	23
September 6—October 4	28	280	.....	140	725	738	13
October 4—November 1	28	280	.....	144	738	776	38
November 1—December 6	35	350	.....	249	776	815	39
December 6—January 3	28	280	.....	224	815	846	31
1895, January 3—January 31	28	280	.....	224	846	894	48
January 31—February 4	35	35	.....	28	894	870	24
Totals	5,215	3,520	4,469	2,255.5			600

* Field corn. † Southern corn silage. ‡ Field corn silage.

TABLE XXX.

SUMMARY SHOWING TOTALS OF FOODS EATEN AND GAINS MADE BY THE FOUR STEERS DURING ENTIRE EXPERIMENT.

	Lot 1. Protein—rich food.		Lot 2. Protein—poor food.	
	Steer 1.	Steer 2.	Steer 3.	Steer 4.
Number of days fed	514	843	833	521
Total hay eaten—pounds	3,414	7,783	6,811	3,520
Total fodder and silage eaten—pounds	4,173	4,728	4,493	4,469
Total mixed grains eaten—pounds	2,211	4,818	4,737	2,255
Total food eaten—pounds	9,700	17,329	16,041	10,234
Initial weights of steers—pounds	221	345	285	318
End weights of steers—pounds	958	1,307	1,290	870
Total gain of each steer—pounds	737	962	1,005	552

TABLE XXXI.

DRY MATTER AND DIGESTIBLE MATTER EATEN BY THE FOUR STEERS DURING THE ENTIRE EXPERIMENT, WITH RELATION OF FOOD TO GROWTH.

	Dry Matter Eaten.				Digestible Matter Eaten.				Nutritive ratio.	Digestible matter eaten for each lb. gain of live wt.
	Protein—pounds.	Carbo-hydrates—pounds.	Fat—pounds.	Total—pounds.	Protein—pounds.	Carbo-hydrates—pounds.	Fat—pounds.	Total—pounds.		
Protein—rich ration.										Lbs.
Steer 1.										
In silage, 4,173 pounds .	89.0	590.6	19.0	698.6	51.4	431.3	15.2	497.9		
In hay, 3,414 pounds...	230.7	2499.4	99.3	2829.4	113.0	1476.9	56.7	1646.6		
In grains, 2,211 pounds.	568.0	1290.2	103.3	1961.5	454.3	961.2	87.8	1503.3		
Total in 514 days....	887.7	4380.2	221.6	5489.5	618.7	2869.4	159.7	3647.8	.....	4.95
Eaten daily.....	1.73	8.52	.43	10.78	1.20	5.58	.32	7.10	1:5.2	
Protein—Poor ration.										
Steer 4.										
In silage, 4,469 pounds .	96.0	635.8	20.5	752.3	55.1	465.6	16.4			
In hay, 3,520 pounds...	237.6	2577.3	102.4	2917.3	116.0	1522.7	57.9			
In grains, 2,255 pounds.	272.9	1553.5	96.6	1923.0	199.2	1275.5	79.2			
Total in 521 days....	606.5	4766.6	219.5	5592.6	370.3	3263.8	153.5	3787.6	.. ...	6.86
Eaten daily	1.16	9.15	.42	10.73	.71	6.26	.30	7.27	1:9.7	
Protein—rich ration.										
Steer 2.										
In silage, 4,728 pounds .	102.2	675.6	21.7	799.5	59.7	487.9	17.4	565.0		
In hay, 7,783 pounds....	526.1	5698.1	226.6	6450.8	257.5	3366.9	129.2	3753.6		
In grains, 4,818 pounds.	1185.2	2685.3	205.1	4075.6	948.2	1997.9	174.3	3120.4		
Total in 843 days....	1813.5	9059.0	453.4	11325.9	1265.4	5852.7	320.9	7439.0	.....	7.73
Eaten daily	2.15	10.74	.54	13.43	1.50	6.95	.38	8.83	1:5.2	
Protein—poor ration.										
Steer 3.										
In silage, 4,493 pounds .	96.6	639.5	20.6	756.7	56.1	468.4	16.5	541.0		
In hay, 6,811 pounds....	460.4	4986.3	198.8	5645.5	225.3	2946.4	113.0	3284.7		
In grains, 4,737 pounds.	573.0	3284.8	201.4	4059.2	418.3	2713.6	165.2	3297.1		
Total in 833 days....	1130.0	8910.6	420.8	10461.4	699.7	6128.4	294.7	7122.8	.....	7.08
Eaten daily..	1.36	10.69	.50	12.55	.84	7.36	.35	8.55	1:9.7	

TABLE XXXII.

SUMMARY OF TABLE XXXI.

	Daily gain in live weight—pounds.	Dry Matter Eaten Daily.				Digestible Material Eaten Daily.				Nutritive ratio.	Digestible matter eaten for each pound gain of live weight—pounds.
		Protein—pounds.	Carbo-hydrates—pounds.	Fats—pounds.	Total—pounds.	Protein—pounds.	Carbo-hydrates—pounds.	Fats—pounds.	Total—pounds.		
PROTEIN—RICH FOOD.											
Steer 1, fed 514 days ...	1.43	1.73	8.52	.43	10.78	1.20	5.58	.32	7.10	1:5.2	4.95
Steer 2, fed 843 days ...	1.14	2.15	10.74	.54	13.43	1.50	6.95	.38	8.83	1:5.2	7.73
PROTEIN—POOR FOOD.											
Steer 3, fed 521 days ...	1.06	1.16	9.15	.42	10.73	.71	6.26	.30	7.27	1:9.7	6.86
Steer 4, fed 833 days ...	1.20	1.36	10.69	.50	12.55	.84	7.36	.35	8.55	1:9.7	7.08

TABLE XXXIII.

DRY AND DIGESTIBLE MATTER EATEN BY THE FOUR STEERS, DURING THE FIRST FIFTEEN MONTHS OF THE EXPERIMENT, CONSIDERED IN FIVE PERIODS, WITH RELATION OF FOOD TO GAIN.

	Dry Matter Consumed in Entire Periods.				Digestible Matter Consumed in Entire Periods.				Total gain in period—pounds.	Digestible food eaten per pound of gain—pounds.
	Protein—pounds.	Carbo-hydrates—pounds.	Fat—pounds.	Total—pounds.	Protein—pounds.	Carbo-hydrates—pounds.	Fat—pounds.	Total—pounds.		
Period 1. 91 days—Sept. 1 to Nov. 30, 1893.										
Steer 1	73.4	469.0	23.0	565.4	48.3	314.6	16.7	379.6	106	3.58
Steer 2	89.5	601.5	27.6	718.6	57.4	405.0	19.9	482.3	106	4.55
Steer 3	68.5	538.92	23.4	630.8	41.4	371.4	16.5	429.3	76	5.65
Steer 4	66.8	528.7	22.8	618.3	40.3	363.2	17.1	420.6	67	6.28
Period 2. 84 days—Dec. 1 to Feb. 22, 1894.										
Steer 1	109.1	574.9	31.2	715.2	73.5	377.9	22.9	474.3	120	3.95
Steer 2	114.5	634.2	33.5	782.2	76.2	412.8	24.3	513.3	112	4.58
Steer 3	78.3	606.2	29.0	713.5	46.5	415.7	20.7	482.9	92	5.25
Steer 4	78.3	606.2	29.0	713.5	46.5	415.7	20.7	482.9	83	5.82
Period 3. 98 days—Feb. 23 to May 31, 1894.										
Steer 1	167.6	749.8	38.6	956.0	117.4	524.2	30.1	671.7	183	3.67
Steer 2	117.0	840.5	42.1	1059.6	122.4	579.8	32.2	724.4	186	3.94
Steer 3	120.7	820.2	37.1	978.0	76.1	607.7	29.5	713.3	168	4.25
Steer 4	120.7	820.2	37.1	978.0	76.1	607.7	29.5	713.3	160	4.46
Period 4. 98 days—June 1 to Sept. 6, 1894.										
Steer 1	174.1	946.6	44.8	1165.5	118.7	594.5	30.1	743.3	128	5.80
Steer 2	180.7	1018.4	47.6	1246.7	121.9	636.8	31.7	790.4	111	7.11
Steer 3	117.0	1009.9	42.2	1169.1	69.5	665.1	27.5	762.1	129	5.90
Steer 4	117.0	1009.9	42.2	1169.1	69.5	665.1	27.5	762.1	97	7.85
Period 5. 91 days—Sept. 7 to Dec. 6, 1894.										
Steer 1	198.3	963.8	48.5	1210.6	139.6	615.2	33.8	788.6	145	5.44
Steer 2	204.5	1030.8	51.1	1286.4	142.6	654.5	35.3	832.4	98	8.50
Steer 3	126.3	1029.1	50.6	1206.0	77.4	693.7	34.9	806.0	112	7.20
Steer 4	126.3	1029.1	50.6	1206.0	77.4	693.7	34.9	806.0	90	8.96

TABLE XXXIV.

DAILY FOOD CONSUMPTION AND GROWTH OF STEERS DURING FIRST FIFTEEN MONTHS OF THE EXPERIMENT, CONSIDERED IN FIVE PERIODS.

		Dry Matter Consumed Daily.				Digestible Matter Consumed Daily.				Daily gain in live weight—pounds.
		Protein—pounds.	Carbo-hydrates—pounds.	Fat—pounds.	Total—pounds.	Protein—pounds.	Carbo-hydrates—pounds.	Fat—pounds.	Total—pounds.	
Period 1. 91 days.										
September 1 to November 30, 1893.										
More protein in ration	Steer 1....	.81	5.15	.25	6.21	.53	3.46	.18	4.17	1.16
	Steer 2....	.98	6.61	.30	7.90	.63	4.45	.22	5.30	1.16
Less protein in ration	Steer 3....	.75	5.92	.25	6.93	.45	4.08	.18	4.72	.83
	Steer 4....	.73	5.82	.25	6.80	.44	4.00	.18	4.62	.73
Period 2. 84 days.										
December 1 to February 22, 1894.										
More protein in ration	Steer 1....	1.30	6.84	.36	8.59	.87	4.50	.27	5.64	1.43
	Steer 2...	1.36	7.55	.40	9.31	.91	4.91	.30	6.11	1.33
Less protein in ration	Steer 3....	.93	7.22	.34	8.49	.55	4.95	.24	5.74	1.10
	Steer 4. ..	.93	7.22	.34	8.49	.55	4.95	.24	5.74	.99
Period 3. 98 days.										
February 23 to May 31, 1894.										
More protein in ration	Steer 1....	1.71	7.65	.40	9.76	1.19	5.35	.31	6.85	1.87
	Steer 2....	1.81	8.59	.43	10.81	1.25	5.91	.33	7.49	1.90
Less protein in ration	Steer 3....	1.23	8.37	.38	9.98	.77	6.20	.30	7.27	1.71
	Steer 4....	1.23	8.37	.38	9.98	.77	6.20	.30	7.27	1.63
Period 4. 98 days.										
June 1 to September 6, 1894.										
More protein in ration	Steer 1...	1.77	9.66	.45	11.88	1.21	6.06	.30	7.57	1.31
	Steer 2 ..	1.84	10.40	.48	12.72	1.24	6.50	.32	8.06	1.13
Less protein in ration	Steer 3....	1.20	10.30	.43	11.93	.71	6.78	.28	7.77	1.31
	Steer 4....	1.20	10.30	.43	11.93	.71	6.78	.28	7.77	1.00
Period 5. 91 days.										
September 7 to December 6, 1894.										
More protein in ration	Steer 1....	2.18	10.59	.53	13.30	1.53	6.76	.37	8.66	1.62
	Steer 2 ...	2.24	11.33	.56	14.13	1.57	7.19	.39	9.14	1.10
Less protein in ration	Steer 3....	1.38	11.31	.55	13.24	.85	7.62	.38	8.85	1.25
	Steer 4....	1.38	11.31	.55	13.24	.85	7.62	.38	8.85	1.00

In order to clearly present the facts relative to the comparative effects of the two rations upon the growth of the steers, as shown by the preceding figures, it is desirable to first review briefly the history of the experiment.

Two pairs of steers were fed, one pair receiving a ration with a nutritive ratio of about 1:5.2 and the other pair, a ration with a much wider nutritive ratio, or one of about 1:9.7. When the experiment had progressed for about seventeen months, one steer from each pair was taken out and slaughtered, and the other two steers were fed for ten months longer. The rations were weighed daily and the steers weekly, and the silage and grains were analyzed, so that it is possible to consider the relations of food growth during the entire experiment or any part of it.

If we consult the foregoing figures we see very clearly that the two rations were quite unlike in their effect during the early stages of the experiment, the nitrogenous ration producing much the larger amount of growth.

As the steers became older and the rations increased in quantity, the difference in the rates of growth produced by the two rations was somewhat less marked, until, at the age of seventeen months, the growth of the two pairs was not greatly unlike.

TABLE XXXV.

	Weight pair fed more protein—pounds.	Weight pair fed less protein—pounds.	Greater weight of protein fed pair—pounds.	Increase of difference in weight.
At beginning of experiment	566	603	—37	
At end of three months	778	746	+32	69
At end of six months	1,010	921	+89	57
At end of nine months	1,379	1,249	+130	41
At end of twelve months	1,618	1,475	+143	13
At end of fifteen months	1,861	1,677	+184	41
At end of seventeen months	1,981	1,807	+174	—10

Not only do the above figures plainly indicate the superiority for the young animals of the ration richer in protein, but the same fact was made very evident by the general condition of the steers. Steers 1 and 2 had an appearance of greater thrift than steers 3 and 4 which was unmistakable.

The superiority of the protein rich over the protein-poor ration during the first year of growth is shown emphatically, also, by the difference in digestible dry matter required in the two cases to produce a pound of growth.

TABLE XXXVI.

DIGESTIBLE MATTER REQUIRED TO PRODUCE ONE POUND OF GROWTH.

	Steers fed more protein.	Steers fed less protein.
During first three months	4.06	5.96
During second three months	4.26	5.53
During third three months	3.83	4.35
During fourth three months	6.45	6.87
During fifth three months	6.97	8.08
Average	5.11	6.16

After two animals were slaughtered at the end of seventeen months, the later results with the other two animals at greater age were not the same. These latter steers were fed ten months longer than the others and during that time the steer eating the ration richer in protein gained 284 pounds and the steer receiving the larger proportion of carbohydrate food gained 377 pounds, a difference in favor of the latter of 93 pounds.

Nothing can be clearer, than that with the particular animals fed, the superiority of the protein-rich ration over the other diminished as the steers increased in age. In seeking for an explanation of this fact we may not go far amiss if we consider that the amount of digestible matter in an animal's food must reach a certain absolute quantity before any can be spared for the formation of new tissues. If the nutritive ratio is wide the small ration of the very young animal supplies so little protein that the quantity is inadequate to meet the demands of the possible active growth of that period of life. When, however, the ration is increased to the capacity of the older and larger animal the absolute quantity of protein fed, even in a wide-ratio ration, is sufficient for a generous growth of tissue. It should be remembered that an animal's capacity for growth does not increase proportionately with the age and weight, or so rapidly as does the capacity for food consumption, consequently with an unvarying nutritive ratio the protein supply is likely to be more nearly adequate with the two-year-old steer than with the yearling. It has been the opinon of the writer for some time that the standard rations known as German rations are entirely consistent with facts in at least two particulars:

1st. They call for a diminishing proportion of protein in the ration of growing animals as the animals proceed toward maturity.

2nd. They call for a larger proportion of protein in the ration of the milch cow than in that of the somewhat mature steer.

We believe that the experiment under discussion gives evidence that tends to substantiate this opinion.

THE INFLUENCE OF THE RATIONS UPON THE COMPOSITION OF THE BODIES OF THE STEERS.

When this experiment was planned it was determined to undertake the somewhat arduous task of making a chemical analysis of the entire bodies of the experimental steers, the purpose of this costly piece of work being to determine whether the composition of their bodies was materially modified by the proportions of nutrients in the food. This plan was carried out and the organs and carcasses of the four animals were analyzed, the only part omitted being the skin and hair. These are believed to be the only fairly complete analyses of the bodies of mature bovines since those made by Lawes & Gilbert nearly forty years ago, whose results were published in 1858.

Separation of parts, sampling and analyses. When the steers were killed the blood was caught in a tub which was set under a small trap door in the floor. The animals were then dressed and the various organs and parts were weighed as soon as removed, the carcasses being also weighed in the green condition.

The various organs and divisions of the body were taken to the laboratory and sampled for analysis as rapidly as the work could be performed. It was not over forty-eight hours after the animals were killed before the samples of all the various parts were secured and in the process of drying.

The manner of obtaining the samples was as follows: In the case of the organs such as the heart, liver, lungs, &c., they were minced very fine by being run through a power Enterprise Meat Chopper. This minced material was thoroughly mixed and then large samples were selected for drying. The flesh of the right side of each carcass was entirely removed from the bones, the muscular tissues and the adipose tissues being separated mechanically as fully as possible and thrown into separate dishes. Both the lean portions and the fat were entirely passed through the meat chopper, large samples being selected from each portion for drying. The lean meat samples were dried and the samples of fat were bottled without drying in air tight jars and kept very cold until analysis. The intestinal and kidney fats were treated in the same way as the body fat.

The samples were brought to an air-dry condition in a drying closet heated by a coil of steam pipe, the temperature of which varied from 50 to 60 degrees C., or 120 to 140 degrees F.

The air-dry samples were finally prepared for analysis by passing them through a mill. The samples of fat which were enclosed in jars

without previous drying were submitted to analysis in the fresh condition, the amount of water in adipose tissue being so small as to allow this. For the determination of the fat in these latter materials by extraction with either, unusually large portions were used, approximately 20 grams, and several single determinations were made from such samples. In fact this precaution was taken in every case where the sample contained so much fat as to render the sampling less perfect than was desirable. The percentages of protein given are those obtained "by difference."

Having then the weights of the various organs and parts of the animals and knowing from analysis their percentage composition, it became possible to calculate the proportions of water, ash, protein and fats in the entire animals as well as in the several divisions of the body.

In the tables which immediately follow are displayed very fully the facts which appear from these mechanical and chemical analyses.

Table XXXVII. Weights of the various organs and parts of the steers' bodies.

Table XXXVIII. Composition of the organs and parts of the steers' bodies in the fresh condition.

Table XXXIX to XLII. Composition of the water-free substance of the organs and parts of the steers' bodies with the calculated weights of ash, protein and fat in the same.

Table XLIII. Composition of the entire bodies of the steers, exclusive of skin and contents of stomach and intestines.

Tables XLIV to XLVII. Composition of the carcasses of the steers.

Tables XLVIII to LI. Composition of the edible portion of the carcasses of the steers.

Table LII. Summary of Tables XLIV to XLVII.

Table LIII. Summary of Tables XLVIII to LI.

Table LIV. Proportions of edible materials in the carcasses of the steers.

Table LV. Summary Table LIV.

Table LVI. Proportions of non-edible material in the entire bodies of steers.

Table LVII. Composition of increased growth of older steers.

TABLE XXXVII.

WEIGHTS OF THE VARIOUS PARTS OF STEERS, IN FRESH CONDITION.

	Protein—Rich Ration.		Protein—Poor Ration.	
	Steer 1—pounds.	Steer 2—pounds.	Steer 3—pounds.	Steer 4—pounds.
Live weight	958.0	1,300.0	1,280.0	870.0
External refuse:				
Skin	73.6	96.0	92.5	64.7
Head	29.9	32.5	34.0	26.5
Feet	18.5	22.9	20.6	15.6
Internal refuse:				
Stomach	25.8	35.7	26.5	26.7
Contents of stomach	126.4	160.8	178.5	91.4
Small intestine	15.4	10.1	9.6	12.6
Large intestine	.....	9.1	7.0	
Contents of small intestine	23.2	12.9	15.4	26.5
Contents of large intestine	.....	17.7	28.7	
Intestinal fat	22.3	40.4	34.5	19.9
Organs:				
Tongue	3.7	4.5	4.5	2.9
Lungs and trachea	6.4	8.9	13.0	7.0
Heart and attachments	6.9	11.7	5.6	5.1
Liver	10.3	12.5	10.7	9.3
Kidneys	1.8	2.5	2.0	1.9
Kidney fat	15.3	22.8	21.4	15.1
Pancreas	1.1	.9	.9	1.1
Spleen	1.4	1.9	2.0	1.5
Bladder, etc	.4	1.3	1.2	.5
Diaphragm	2.6	3.9	4.6	2.9
Gall bladder and contents	.9	.6	.4	.6
Blood	34.3	49.8	46.3	38.3
Fore quarter, right side	127.6	173.5	175.0	123.2
Hind quarter, right side	146.9	195.0	195.0	131.4
Fore quarter, left side	278.7	165.0	162.5	259.2
Hind quarter, left side	.....	207.0	200.0	
Whole carcass	553.2	740.5	732.5	513.8

TABLE XXXVIII.

COMPOSITION OF THE ORGANS AND PARTS OF THE STEERS' BODIES, IN THE FRESH CONDITION.

External Refuse.		Water—per cent.	Water-free substance—per cent.	Protein—per cent.	Fat—per cent.	Ash—per cent.
Lean meat of head	Steer 1	67.04	32.96	18.26	13.79	.91
	Steer 2	68.38	31.62	17.86	12.76	1.03
	Steer 3	69.30	30.7	18.31	11.43	.96
	Steer 4	80.27	19.73	11.73	7.40	.60
Fat of head	Steer 1	20.40	79.60	14.61	64.50	.49
	Steer 2	8.40	91.60	27.34	63.68	.58
	Steer 3	10.90	89.10	19.70	68.38	1.02
	Steer 4	31.80	68.20	10.67	57.04	.49
Bones of head	Steer 1	18.91	81.09	35.25	13.33	32.51
	Steer 2	25.10	74.90	23.87	19.22	31.81
	Steer 3	24.70	75.30	26.34	18.59	30.37
	Steer 4	16.10	83.90	30.01	16.37	37.52
Feet	Steer 1	32.23	67.77	35.71	11.24	20.82
	Steer 2	32.60	67.40	35.55	9.29	22.56
	Steer 3	37.40	62.60	29.99	11.41	21.20
	Steer 4	31.30	68.70	33.53	14.38	20.79
Internal Refuse.						
Stomachs	Steer 1	75.68	24.32	13.91	9.49	.91
	Steer 2	72.62	27.38	14.62	11.09	1.67
	Steer 3	73.80	26.20	12.65	12.00	1.55
	Steer 4	74.55	25.45	13.40	10.84	1.21
Large intestines	Steer 2	72.69	27.31	9.01	16.89	1.41
	Steer 3	68.97	31.03	11.76	18.38	.89
Small intestines	Steer 2	44.00	56.00	16.25	37.91	1.79
	Steer 3	82.66	17.34	6.64	10.08	.62
Large and small intestines	Steer 1	78.70	21.30	8.03	12.53	.74
	Steer 4	74.37	25.63	11.43	13.02	1.18
Intestinal fat	Steer 1	9.60	90.40	3.29	86.90	.21
	Steer 2	6.40	93.60	2.19	91.28	.13
	Steer 3	5.90	94.10	4.32	89.68	.10
	Steer 4	10.40	89.60	3.68	85.74	.18
Blood	Steer 1	81.83	18.17	17.26	.10	.81
	Steer 2	82.70	17.30	16.46	.08	.76
	Steer 3	80.62	19.38	18.55	.11	.72
	Steer 4	82.38	17.62	16.82	.10	.70
Bladder	Steer 1	61.00	39.00	28.03	9.77	1.20
	Steer 2	65.29	34.71	18.02	15.86	.83
	Steer 3	62.52	37.48	16.26	20.49	.73
	Steer 4	74.22	25.78	19.80	5.11	.87
Diaphragm	Steer 1	61.50	38.50	18.18	19.52	.80
	Steer 2	47.20	52.80	17.43	34.56	.81
	Steer 3	52.94	47.06	16.87	29.60	.59
	Steer 4	53.36	46.64	17.10	28.81	.73
Thorax fat	Steer 1	22.67	77.33	6.84	70.10	.39
	Steer 4	18.90	81.10	7.98	72.81	.31
Heart attachments	Steer 1	40.70	59.30	9.57	49.23	.50

TABLE XXXVIII—CONCLUDED.

COMPOSITION OF THE ORGANS AND PARTS OF THE STEERS' BODIES, IN THE FRESH CONDITION.

ORGANS.		Water—per cent.	Water-free substance—per cent.	Protein—per cent.	Fat—per cent.	Ash—per cent.
Tongue	Steer 1	68.94	31.06	16.90	13.27	.89
	Steer 2	61.63	38.37	15.40	22.22	.75
	Steer 3	64.03	35.97	15.17	19.91	.89
	Steer 4	65.80	34.20	16.68	16.57	.95
Liver	Steer 1	71.28	28.72	23.18	4.00	1.54
	Steer 2	69.37	30.63	23.93	4.99	1.71
	Steer 3	72.01	27.99	22.55	3.94	1.50
	Steer 4	70.24	29.76	23.86	4.17	1.73
Heart	Steer 1	69.11	30.89	15.17	14.70	1.02
	Steer 2	52.58	47.42	13.76	33.05	.61
	Steer 3	56.26	43.74	18.53	24.37	.84
	Steer 4	60.05	39.95	12.37	26.89	.69
Lungs and trachea	Steer 1	78.15	21.85	17.10	3.65	1.10
	Steer 2	52.65	47.35	33.23	11.55	2.57
	Steer 3	66.21	33.79	15.87	17.01	.91
	Steer 4	77.06	22.94	15.80	5.74	1.40
Kidneys	Steer 1	75.02	24.98	15.44	8.27	1.27
	Steer 2	75.83	24.17	14.95	8.13	1.09
	Steer 3	78.26	21.74	14.70	5.83	1.21
	Steer 4	76.97	23.03	15.52	6.36	1.15
Pancreas	Steer 1	64.58	35.42	16.26	17.69	1.47
	Steer 2	67.76	32.24	16.35	13.82	2.07
	Steer 3	68.63	31.37	14.79	14.91	1.67
	Steer 4	67.83	32.17	16.06	14.60	1.50
Spleen	Steer 1	76.12	23.88	17.38	5.03	1.47
	Steer 2	76.78	23.22	17.56	4.08	1.58
	Steer 3	75.63	24.37	16.29	6.80	1.28
	Steer 4	76.41	23.59	18.48	3.61	1.50

TABLE XXXIX.

COMPOSITION OF WATER-FREE SUBSTANCE OF PARTS OF STEERS' BODIES, WITH WEIGHTS OF ASH, PROTEIN AND FAT.

STEER 1.

	Water-free substance—pounds.	Composition of Water-Free Substance.			Weights of		
		Protein—per cent.	Fat—per cent.	Ash—per cent.	Protein—pounds.	Fat—pounds.	Ash—pounds.
Lean meat of head, exclusive of tongue,	3.6	55.4	41.8	2.8	1.99	1.51	.10
Fat of head	.9	18.3	81.1	.6	.16	.73	.01
Bones of head	8.7	43.5	16.4	40.1	3.79	1.42	3.49
Feet	9.3	52.7	16.6	30.7	4.90	1.54	2.86
Stomachs	6.3	57.2	39.1	3.7	3.60	2.47	.23
Small intestine / Large intestine	3.3	37.7	58.8	3.5	1.24	1.94	.12
Intestinal fat	19.6	3.7	96.1	.2	.73	18.83	.04
Diaphragm	1.0	47.2	50.7	2.1	.47	.51	.02
Bladder	.2	71.9	25.0	3.1	.14	.05	.01
Tongue	1.1	54.4	42.7	2.9	.60	.47	.03
Liver	3.0	80.7	13.9	5.4	2.42	.42	.16
Heart and attachments	6.5	18.5	80.3	1.2	1.20	5.22	.08
Lungs and trachea	1.4	78.2	16.7	5.1	1.09	.24	.07
Kidneys	.2	61.8	33.1	5.1	.14	.07	.01
Kidney fat	7.4	1.6	98.3	.1	.11	7.28	.01
Pancreas	.4	45.9	50.0	4.1	.18	.20	.02
Spleen	.3	72.7	21.1	6.2	.22	.06	.02
Blood	6.2	95.0	.6	4.4	5.89	.04	.27
Bones of carcass	26.7	43.5	16.4	40.1	11.61	4.38	10.71
Lean meat of fore quarter, right side	26.2	64.7	32.2	3.1	16.94	8.44	.82
Fat of fore quarter, right side	10.8	8.9	90.7	.4	.96	9.80	.04
Lean meat of hind quart'r, right side	26.7	69.8	26.9	3.3	18.64	7.18	.88
Fat of hind quarter, right side	14.5	5.0	94.7	.3	.73	13.73	.04
*Left side of carcass	114.2	43.7	45.2	11.1	49.91	51.62	12.67
	298.5				127.65	138.15	32.71

*Assumed to have the same composition as the right side.

TABLE XL.

COMPOSITION OF WATER-FREE SUBSTANCE OF STEERS' BODIES, WITH WEIGHTS OF ASH, PROTEIN AND FAT.

STEER 2.

	Water-free substance—pounds.	Composition of Water-Free Substance.			Weights of		
		Protein—per cent.	Fat—per cent.	Ash—per cent.	Protein—pounds.	Fat—pounds.	Ash—pounds.
Lean meat of head, exclusive of tongue	3.6	56.3	40.4	3.3	2.03	1.45	.12
Fat of head	2.3	29.9	69.5	.6	.69	1.60	.01
Bones of head	12.2	31.9	25.6	42.5	3.89	3.13	5.18
Feet	15.1	52.7	13.8	33.5	7.96	2.08	5.06
Stomachs	9.4	53.4	40.5	6.1	5.02	3.81	.57
Small intestine	5.4	29.0	67.8	3.2	1.57	3.66	.17
Large intestine	2.4	33.0	61.8	5.2	.79	1.48	.12
Intestinal fat	37.3	2.4	97.5	.1	.90	36.37	.04
Diaphragm	2.0	33.0	65.5	1.5	.66	1.31	.03
Bladder	.4	51.9	45.7	2.4	.21	.18	.01
Tongue	1.7	40.1	57.9	2.0	.66	.95	.03
Liver	3.8	78.1	16.3	5.6	2.97	.62	.21
Heart and attachments	3.6	29.0	69.7	1.3	1.04	2.51	.05
Lungs and trachea	4.2	70.2	24.4	5.4	2.95	1.02	.23
Kidneys	.3	61.9	33.6	4.5	.19	.10	.01
Kidney fat	11.1	2.5	97.4	.1	.28	10.81	.01
Pancreas	2.9	50.7	42.9	6.4	1.47	1.24	.19
Spleen	.4	75.6	17.6	6.8	.33	.08	.03
Blood	8.6	95.1	.4	4.4	8.18	.04	.38
Bones of carcass	40.4	31.9	25.6	42.5	12.89	10.34	17.17
Lean meat of fore quarter, right side	34.1	58.1	38.8	3.0	19.85	13.23	1.02
Fat of fore quarter, right side	23.1	10.6	89.0	.4	2.45	20.56	.09
Lean meat of hind quarter, right side	33.8	65.9	30.8	3.3	22.28	10.41	1.12
Fat of hind quarter, right side	34.4	12.9	86.8	.3	4.44	29.86	.10
Left side of carcass	182.5	35.2	53.8	11.0	64.24	98.19	20.07
	475.0				167.94	255.03	52.02

TABLE XLI.

COMPOSITION OF WATER-FREE SUBSTANCE OF STEERS' BODIES, WITH WEIGHTS OF ASH, PROTEIN AND FAT.

STEER 3.

	Water-free substance—pounds.	Composition of Water-Free Substance.			Weights of		
		Protein—per cent.	Fat—per cent.	Ash—per cent.	Protein—pounds.	Fat—pounds.	Ash—pounds.
Lean meat of head, exclusive of tongue,	3.2	59.7	37.2	3.1	1.91	1.19	.10
Fat of head	3.0	22.1	76.7	1.2	.66	2.30	.00
Bones of head	11.9	35.0	24.7	40.3	4.16	2.94	4.80
Feet	12.9	47.9	18.2	33.9	6.18	2.35	4.37
Stomachs	6.8	48.3	45.8	5.9	3.28	3.11	.40
Small intestine	1.6	38.3	58.1	3.6	.61	.93	.06
Large intestine	2.1	37.9	59.2	2.9	.79	1.24	.06
Intestinal fat	31.5	4.6	95.3	.1	1.45	30.01	.04
Diaphragm	2.1	35.8	62.9	1.3	.75	1.32	.03
Bladder	.4	43.4	54.7	1.9	.17	.22	.01
Tongue	1.6	42.2	55.3	2.5	.67	.89	.04
Liver	3.0	80.6	14.0	5.4	2.42	.42	.16
Heart and attachments	2.9	42.4	55.7	1.9	1.23	1.62	.06
Lungs and trachea	4.2	47.0	50.3	2.7	1.97	2.12	.11
Kidneys	.2	67.6	26.8	5.6	.13	.05	.01
Kidney fat	10.4	2.4	97.5	.1	.25	10.15	.01
Pancreas	.3	47.2	47.5	5.3	.14	.14	.02
Spleen	.5	66.8	27.9	5.3	.33	.14	.02
Blood	9.0	95.7	.6	3.7	8.61	.05	.33
Bones of carcass	44.0	35.0	24.7	40.3	15.39	10.86	17.75
Lean meat of fore quarter, right side	32.6	65.0	31.9	3.1	21.20	10.39	1.01
Fat of fore quarter, right side	25.1	10.0	89.6	.4	2.50	22.50	.10
Lean meat of hind quarter, right side	31.9	69.0	27.6	3.4	22.03	8.80	1.07
Fat of hind quarter, right side	32.8	5.4	94.3	.3	1.78	30.92	.10
Left side of carcass	175.6	35.75	52.92	11.35	62.77	92.93	19.90
	449.6				161.38	237.60	50.56

TABLE XLII.

COMPOSITION OF WATER-FREE SUBSTANCE OF STEERS' BODIES, WITH WEIGHTS OF ASH, PROTEIN AND FAT.

STEER 4.

	Water-free substance—pounds.	Composition of Water-Free Substance.			Weights of		
		Protein—per cent.	Fat—per cent.	Ash—per cent.	Protein—pounds.	Fat—pounds.	Ash—pounds.
Lean meat of head, exclusive of tongue,	1.9	59.4	37·5	3.1	1.13	.71	.06
Fat of head	1.5	15.7	83.6	.7	.23	1.26	.01
Bones of head	8.9	44.7	35.8	19.5	3.98	3.19	1.73
Feet	12.5	48.8	20.9	30.3	6.10	2.62	3.78
Stomachs	6.3	52.6	42.6	4.8	3.32	2.68	.30
Small intestine / Large intestine	3.2	44.6	50.8	4.6	1.43	1.62	.15
Intestinal fat	17.9	4.1	95.7	.2	.73	17.13	.04
Diaphragm	1.4	36.7	61.7	1.6	.51	.87	.02
Bladder	.1	76.8	19.8	3.4	.08	.02	.00
Tongue	1.0	48.8	48.4	2.8	.49	.48	.03
Liver	2.8	80.2	14.0	5.8	2.25	.39	.16
Heart and attachments	3.5	14.3	85.1	.6	.50	2.98	.02
Lungs and trachea	1.6	68.9	25.0	6.1	1.10	.40	.10
Kidneys	.2	67.4	27.6	5.0	.13	.06	.01
Kidney fat	7.2	2.6	97.3	.1	.18	7.01	.01
Pancreas	.3	49.9	45.4	4.7	·15	.14	.01
Spleen	.4	78.3	15.3	6.4	.31	.06	.03
Blood	6.8	95.5	.6	3.9	6.49	.04	.27
Bones of carcass	28.1	35.8	19.5	44.7	10.06	5.48	12.54
Lean meat of fore quarter, right side	24.5	64.9	31.9	3.2	15.91	7.81	.78
Fat of fore quarter, right side	11.8	3.9	95.8	.3	.46	11.30	.04
Lean meat of hind quarter, right side	26.9	65.1	31.7	3.2	17.51	8.53	.86
Fat of hind quarter, right side	12.6	8.7	91.0	.3	1.10	11.46	.03
Left side of carcass	113.3	40.77	46.39	12.84	46.20	52.55	14.55
	294.7				120.35	138.79	35.53

TABLE XLIII.

PERCENTAGE COMPOSITION OF ENTIRE BODIES OF STEERS, EXCLUSIVE OF SKIN AND CONTENTS OF STOMACHS AND INTESTINES.

	In Fresh Condition.				In Water-free Substance.		
	Water—per cent.	Protein—per cent.	Fat—per cent.	Ash—per cent.	Protein—per cent.	Fat—per cent.	Ash—per cent.
Steer 1. Protein-rich ration	59.37	17.38	18.80	4.45	42.78	46.28	10.94
Steer 2. Protein-rich ration	53.09	16.59	25.18	5.14	35.37	53.68	10.95
Steer 3. Protein-poor ration	53.41	16.73	24.62	5.24	35.91	52.84	11.25
Steer 4. Protein-poor ration	57.13	17.51	20.19	5.17	40.85	47.10	12.05

TABLE XLIV.

COMPOSITION OF RIGHT SIDE OF CARCASS.

STEER 1.

	Weights.		Weights of Constituents.			
	Fresh—pounds.	Water-free—pounds.	Water—pounds.	Protein—pounds.	Fat—pounds.	Ash—pounds.
Lean of fore quarter	87.81	26.15	61.66	16.92	8.42	.81
Fat of fore quarter	13.24	10.80	2.44	.96	9.80	.04
Lean of hind quarter	94.06	26.70	67.36	18.64	7.18	.88
Fat of hind quarter	17.03	14.50	2.53	.73	13.73	.04
Kidney	.91	.23	.68	.14	.07	.02
Kidney fat	7.57	7.40	.17	.11	7.28	.01
Bones of carcass	32.90	26.70	6.20	11.61	4.38	10.71
Whole side	253.52	112.48	141.04	49.11	50.86	12.51
			%	%	%	%
Percentage composition	.....	.....	59.02	17.89	18.53	4.56
Percentage composition water-free	.....	.....	.....	43.66	45.23	11.11

TABLE XLV.

COMPOSITION OF RIGHT SIDE OF CARCASS.

STEER 2.

	Weights.		Weights of Constituents.			
	Fresh—pounds.	Water-free pounds.	Water—pounds.	Protein—pounds.	Fat—pounds.	Ash—pounds.
Lean of fore quarter	109.9	34.1	75.80	19.85	13.23	1.02
Fat of fore quarter	30.3	23.1	7.20	2.45	20.56	.09
Lean of hind quarter	114.9	33.8	81.10	22.28	10.41	1.12
Fat of hind quarter	40.9	34.4	6.50	4.44	29.86	.10
Kidney	1.3	.3	1.00	.19	.10	.01
Kidney fat	11.4	11.1	.30	.28	10.81	.01
Bones of carcass	53.9	40.4	13.50	12.89	10.34	17.17
Whole side	362.6	177.2	185.40	62.38	95.31	19.52
Percentage composition	.....	.....	% 51.91	% 16.93	% 25.86	% 5.30
Percentage composition water-free	.....	.....	.....	35.20	53.78	11.02

TABLE XLVI.

COMPOSITION OF RIGHT SIDE OF CARCASS.

STEER 3.

	Weights.		Weights of Constituents.			
	Fresh—pounds.	Water-free—pounds.	Water—pounds.	Protein—pounds.	Fat—pounds.	Ash—pounds.
Lean of fore quarter	107.7	32.6	75.10	21.20	10.39	1.01
Fat of fore quarter	31.7	25.1	6.60	2.50	22.49	.10
Lean of hind quarter	110.0	31.9	78.10	22.04	8.80	1.07
Fat of hind quarter	39.5	32.8	6.70	1.78	30.92	.10
Kidney	1.0	.2	.80	.13	.05	.01
Kidney fat	10.7	10.4	.30	.25	10.15	.01
Bones of carcass	58.4	44.0	14.40	15 39	10.86	17.75
Whole side	359.0	177.0	182.00	63.29	93.66	20.05
Percentage composition	.....	.....	% 52.16	% 17.10	% 25.32	% 5.42
Percentage composition water-free	.....	.....	.....	35.75	52.90	11.35

XLVII.

COMPOSITION OF RIGHT SIDE OF CARCASS.

STEER 4.

	Weights.		Weights of Constituents.			
	Fresh—pounds.	Water-free—pounds.	Water—pounds.	Protein—pounds.	Fat—pounds.	Ash—pounds.
Lean of fore quarter	80.80	24.50	56.30	15.91	7.81	.78
Fat of fore quarter	14.37	11.80	2.57	.46	11.30	.04
Lean of hind quarter	85.42	26.90	58.52	17.51	8.53	.86
Fat of hind quarter	14.27	12.60	1.67	1.10	11.46	.03
Kidneys	.95	.20	.75	.13	.06	.01
Kidney fat	7.49	7.20	.29	.18	6.97	.01
Bones of carcass	33.46	28.10	5.36	10.05	5.48	12.54
Whole side	236.76	111.30	125.46	45.34	51.61	14.27
			%	%	%	%
Percentage composition	.....	.....	56.30	17.82	20.27	5.61
Percentage composition water-free	.....	.....	.....	40.77	46.39	12.84

TABLE XLVIII.

COMPOSITION OF THE EDIBLE PORTION OF THE CARCASS.

STEER 1.

	Weights.		Weights of Constituents.			
	Fresh—pounds.	Water-free—pounds.	Water—pounds.	Protein—pounds.	Fat—pounds.	Ash—pounds.
Lean of fore quarter	87.8	26.15	61.65	16.92	8.42	.81
Fat of fore quarter	13.3	10.80	2.50	.96	9.80	.04
	101.1	36.95	64.15	17.88	18.22	.85
			%	%	%	%
Percentage composition fore quarter	.....	.....	63.46	17.69	18.01	.84
Percentage composition water-free	.....	.....	.....	48.41	49.28	2.31
			lbs.	lbs.	lbs.	lbs.
Lean of hind quarter	94.1	26.7	67.4	18.64	7.18	.88
Fat of hind quarter	17.0	14.5	2.5	.73	13.73	.04
	111.1	41.2	69.9	19.37	20.91	.92
			%	%	%	%
Percentage composition hind quart'r	.....	.....	62.91	17.44	18.82	.83
Percentage composition water-free	.....	.....	.....	47.02	50.75	2.23
			lbs.	lbs.	lbs.	lbs.
Fore quarter	101.1	36.95	64.15	17.88	18.22	.85
Hind quarter	111.1	41.20	69.90	19.37	20.91	.92
	212.2	78.15	134.05	37.25	39.13	1.77
			%	%	%	%
Percentage composition of side	.....	.....	63.18	17.56	18.44	.82
Percentage composition water-free	.....	.....	.....	47.66	50.07	2.27

TABLE XLIX.

COMPOSITION OF THE EDIBLE PORTION OF THE CARCASS.

STEER 2.

	Weights.		Weights of Constituents.			
	Fresh—pounds.	Water-free—pounds.	Water—pounds.	Protein—pounds.	Fat—pounds.	Ash—pounds.
Lean of fore quarter	109.9	34.1	75.80	19.85	13.25	1.02
Fat of fore quarter	30.3	23.1	7.20	2.45	20.56	.09
	140.2	57.2	23.00	22.30	33.79	1.11
			%	%	%	%
Percentage composition fore quarter	.....	.....	59.20	15.90	24.10	.79
Percentage composition water-free	.....	.....	.....	38.99	59.07	1.94
			lbs.	lbs.	lbs.	lbs.
Lean of hind quarter	114.9	33.8	81.10	22.28	10.41	1.12
Fat of hind quarter	40.9	34.4	6.50	4.44	29.86	.10
	155.8	68.2	87.60	26.72	40.27	1.22
			%	%	%	%
Percentage composition hind quart'r	.....	.....	56.24	17.15	25.85	.76
Percentage composition water-free	.....	.....	.....	39.18	59.04	1.78
			lbs.	lbs.	lbs.	lbs.
Fore quarter	140.2	57.2	83.00	22.30	33.79	1.11
Hind quarter	155.8	68.2	87.60	26.72	40.27	1.22
	296.0	125.4	170.60	49.02	74.06	2.33
			%	%	%	%
Percentage composition of side	.....	.....	57.63	16.56	25.03	.78
Percentage composition water-free	.....	.....	.....	39.09	59.05	1.86

TABLE L.

COMPOSITION OF THE EDIBLE PORTION OF THE CARCASS.

STEER 3.

	Weights.		Weights of Constituents.			
	Fresh—pounds.	Water-free pounds.	Water—pounds.	Protein—pounds.	Fat—pounds.	Ash—pounds.
Lean of fore quarter	107.7	32.6	75.10	21.20	10.39	1.01
Fat of fore quarter	31.7	25.1	6.60	2.50	22.49	.10
	139.4	57.7	81.70	23.70	32.88	1.11
			%	%	%	%
Percentage composition fore quarter	.....	.....	58.61	17.00	23.59	.80
Percentage composition water-free	.....	.....	.....	41.08	56.99	1.92
			lbs.	lbs.	lbs.	lbs.
Lean of hind quarter	110.0	31.9	78.10	22.04	8.80	1.07
Fat of hind quarter	39.5	32.8	6.70	1.78	30.92	.10
	149.5	64.7	84.80	23.82	39.72	1.17
			%	%	%	%
Percentage composition hind quart'r	.....	.....	56.71	15.94	26.57	.78
Percentage composition water-free	.....	.....	.....	36.82	61.38	1.80
Fore quarter	139.4	57.7	81.70	23.70	32.88	1.11
Hind quarter	149.5	64.7	84.80	23.82	39.72	1.17
	288.9	122.4	166.50	47.52	72.60	2.28
			%	%	%	%
Percentage composition of side	.....	.....	57.63	16.45	25.13	.79
Percentage composition water-free	.....	.....	.....	38.83	59.31	1.86

TABLE LI.

COMPOSITION OF THE EDIBLE PORTION OF THE CARCASS.

STEER 4.

	Weights.		Weights of Constituents.			
	Fresh—pounds.	Water-free—pounds.	Water—pounds.	Protein—pounds.	Fat—pounds.	Ash—pounds.
Lean of fore quarter	80.8	24.5	56.30	15.91	7.81	.78
Fat of fore quarter	14.4	11.8	2.60	.46	11.30	.04
	95.2	36.3	58.90	16.37	19.11	.82
			%	%	%	%
Percentage composition fore quarter	.....	.....	61.87	17.20	20.07	.86
Percentage composition water-free	.....	.....	.....	45.10	52.64	2.26
			lbs.	lbs.	lbs.	lbs.
Lean of hind quarter	85.4	26.9	58.50	17.51	8.53	.86
Fat of hind quarter	14.3	12.6	1.70	1.10	11.46	.03
	99.7	39.5	60.20	18.61	19.99	.89
			%	%	%	%
Percentage composition hind quart'r	.....	.....	60.38	18.67	20.06	.89
Percentage composition water-free	.....	.....	.....	47.12	50.63	2.25
			lbs.	lbs.	lbs.	lbs.
Fore quarter	95.2	36.3	58.90	16.37	19.11	.82
Hind quarter	99.7	39.5	60.20	18.61	19.99	.89
	194.9	75.8	119.10	34.98	39.10	1.71
			%	%	%	%
Percentage composition of side	.....	.....	61.12	17.94	20.06	.88
Percentage composition water-free	.....	.....	.....	46.15	51.59	2.26

TABLE LII.

PERCENTAGE COMPOSITION OF TOTAL DRESSED CARCASS.

		In Fresh Substance.				In Water-Free Substance.		
		Water—per cent.	Protein—per cent.	Fat—per cent.	Ash—per cent.	Protein—per cent.	Fat—per cent.	Ash—per cent.
Protein rich food	Steer 1, fed 17 months	59.02	17.89	18.53	4.56	43.66	45.23	11.11
	Steer 2, fed 27 months	51.91	16.93	25 86	5.30	35.20	53.78	11.02
Protein poor food	Steer 3, fed 27 months	52.16	17.10	25.32	5.42	35.75	52.90	11.35
	Steer 4, fed 17 months	56.30	17.82	20.27	5.61	40.77	46.39	12.84

TABLE LIII.

COMPOSITION OF EDIBLE PORTION OF DRESSED CARCASSES, EXCLUSIVE OF KIDNEY FAT.

	In Fresh Substance.				In Water-Free Substance.		
	Water—per cent.	Protein—per cent.	Fat—per cent.	Ash—per cent.	Protein—per cent.	Fat—per cent.	Ash—per cent.
Fore quarter, steer 1	63.46	17.69	18.01	.84	48.41	49.28	2.31
2	59.21	15.90	24.10	.79	38.99	59.07	1.94
3	58.01	17.25	23.93	.81	41.08	56.99	1.93
4	61.87	17.20	20.07	.86	45.10	52.64	2.26
Hind quarter, steer 1	62.91	17.44	18.82	.83	47.02	50.75	2.23
2	56.24	17.15	25.85	.76	39.18	59.04	1.78
3	56.71	15.94	26.57	.78	36.82	61.38	1.80
4	60.38	18.67	20.06	.89	47.12	50.63	2.25
Total side, steer 1	63.18	17.56	18.44	.82	47.66	50.07	2.27
2	57.63	16.56	25.03	.78	39.09	59.05	1.86
3	57.34	16.56	25.30	.80	38.83	59.31	1.86
4	61.12	17.94	20.06	.88	46.15	51.59	2.26

TABLE LIV.

PROPORTIONS OF EDIBLE NUTRIENTS IN THE CARCASS.

	Refuse—%.	Edible portion—%.	Edible Portion.				
			Water—%.	Water-free—%.	Nutrients.		
					Protein—%.	Fat—%.	Ash—%.
Steer 1.							
Total fore quarter	18.30	81.70	52.74	28.96	14.02	14.27	.67
Total hind quarter	13.07	86.93	53.85	33.08	13.26	19.19	.63
Total hind quarter without kidney fat	13.78	82.22	54.01	28.21	13.26	14.32	.63
Whole side	15.52	84.43	53.31	31.17	13.61	16.91	.65
Whole side without kidney fat	15.97	84.03	54.75	29.28	13.95	14.66	.67
Steer 2.							
Total fore quarter	16.83	83.17	50.20	32.97	12.85	19.48	.64
Total hind quarter	13.54	86.46	45.79	40.67	13.84	26.20	.63
Total hind quarter without kidney fat	14.38	85.62	46.06	39.56	15.50	23.36	.70
Whole side	15.09	84.91	47.87	37.04	13.37	23.04	.63
Whole side without kidney fat	15.57	84.43	49.31	35.12	13.73	20.74	.65
Steer 3.							
Total fore quarter	18.51	81.49	48.52	32.97	13.55	18.79	.63
Total hind quarter	13.90	86.10	47.60	38.50	12.34	25.56	.60
Total hind quarter without kidney fat	14.70	85.30	50.20	35.10	12.92	21.55	.63
Whole side	16.08	83.92	48.03	35.89	12.91	22.36	.62
Whole side without kidney fat	16.56	83.44	49.38	34.06	13.22	20.20	.64
Steer 4.							
Total fore quarter	17.54	82.46	52.99	29.47	13.29	15.51	.67
Total hind quarter	14.57	85.43	49.88	35.55	14.31	20.55	.69
Total hind quarter without kidney fat	15.46	84.54	52.65	31.89	15.02	16.15	.72
Whole side	16.00	84.00	51.39	32.61	13.82	18.11	.68
Whole side without kidney fat	16.49	83.51	52.83	30.68	14.16	15.83	.69

TABLE LV.

PROPORTIONS OF EDIBLE MATERIAL IN THE DRESSED CARCASSES OF THE FOUR STEERS.

	Total water-free edible material—per cent.	NUTRIENTS, PROPORTIONS OF EDIBLE.		
		Protein—per cent.	Fat—per cent.	Ash—per cent.
Whole side, without kidney fat, steer 1	29.28	13.95	14.66	.67
2	35.12	13.73	20.74	.65
3	34.06	13.22	20.20	.64
4	30.68	14.16	15.83	.69

The most important consideration in the experiment which we are now discussing is the relative influence of widely different rations upon the development and composition of the bodies of the experimental animals. We have seen that one pair of steers was fed a much larger amount of protein, both absolutely and relatively to the other food constituents, than the other pair.

Of the two steers killed at the end of seventeen months, Steer 1 ate 619 pounds of digestible protein and 3029 pounds of digestible carbohydrates and fats, while Steer 4 ate 370 pounds of digestible protein and 3418 pounds of digestible carbohydrates and fats.

In the case of the two steers killed at the end of twenty-seven months Steer 2 ate 1265 pounds of digestible protein and 6174 pounds of digestible carbohydrates and fats, and Steer 3 ate 700 pounds of digestible protein and 6422 pounds of digestible carbohydrates and fats. In other words, one pair of steers ate nearly eighty per cent. more protein than the other pair. Did this difference in the nutrition of the animals cause material variations in the general development of their bodies, in the proportionate weights of their parts or in the relative quantities of the four classes of constituents water, ash, protein and fat? We have seen that the protein-rich ration caused a more rapid growth of the steers while they were quite young. Did it cause a different growth?

In endeavoring to answer this question we must be controlled by the facts secured with reference to

(1) The relative weights of the organs and parts of the bodies.
(2) The percentage composition of the different organs and parts.
(3) The percentage composition of the body as a whole.
(4) The percentage composition of the carcass.

(5) The percentage composition of the edible portions of the carcass.

(6) The relative amounts of edible material.

It must be borne in mind in this discussion that Steer 1 must be compared with Steer 4, and Steer 2 with Steer 3.

(1) *The relative weights of organs and parts.* Reference to Table shows no marked differences in the relative weights of the different organs and parts.

The proportion of carcass weight, for instance, varies but little in the four animals, as is shown below.

	Steer 1—per cent.	Steer 2—per cent.	Steer 3—per cent.	Steer 4—per cent.
Carcass in per cent of live weight	57.7	57.0	57.2	59.0
Proportion of carcass in body minus the skin and contents of the stomach and intestines.	75.2	73.1	75.9	74.8

A glance at the weights of the different organs reveals no evidence that the larger protein supply caused a more vigorous development of any one of them, neither does it appear that the greater carbohydrate supply increased the quantities of intestinal or kidney fats.

(2) *Composition of the fresh organs and parts.* The figures of Tables XXXVIII to XLII show that the composition of the various organs and parts of the four steers' bodies was somewhat variable, but there are no differences in this respect which can logically be attributed to the food. The great variation in the water content in the heart is accounted for in part by the greater or less amounts of fat and other attachments which were ground up with that organ. In the case of the lungs there appears to be no reasonable explanation of the greatly different percentage composition. The figures hint at an error, but a careful examination of the original data does not reveal any.

(3) *Percentage composition of the entire bodies, exclusive of skin and contents of stomach and intestines.* In Tables XXXIX to XLII are calculated the total quantities of protein, fat and ash in the bodies of the several animals, the skin and contents of stomachs and intestines being ignored. Having these figures and knowing the weights of all the parts in the fresh condition, it is possible to compute the percentage composition of the bodies of the animals as they existed before being killed. This has been done and the results appear in Table XLIII. There certainly is a striking similarity in the composition of the bodies of the steers of the same age. It is very noticeable that the older steers contain a less proportion of water and protein and a larger proportion of fat, but when we compare Steer 1 with Steer 4, and Steer 2 with 3, the differences are not important, and

we fail to discover any indication that the unlike rations have caused unlike growth of tissues.

(4) *Percentage composition of the carcasses (dressed beef.)* The carcasses have the same similarity of composition that the entire bodies do. Comparing the dressed beef from the steers of the same age we find essentially the same proportions of water, ash, protein and fat.

We observe here as in the case of the entire bodies that the older and more mature and fatter animals furnish beef with a smaller proportion of water and protein and a larger proportion of fat than the younger animals do.

(5) *Composition of the edible portion of the carcasses.* This includes in these cases all of the carcass but the bones. Some other material is not edible, such as certain connective tissues (tendons, cartilage &c.) and which would find its way into the kitchen refuse. The bones were all the non-edible portion, however, which it was easy to separate, and the proportion of edible material is not greatly too large. We still fail to find that the unlike rations have caused essential variations in the proportion of water or of any class of constituents in the flesh of the animals. As noted with the dressed beef, the edible parts of the carcasses of the older and maturer steers contain smaller proportions of water and protein and larger proportions of fat than is the case with the younger animals. This fact, though not new, endorses the popular belief that "young" beef does not "spend" as well as that from maturer animals.

The writer is obliged to confess that he is surprised at the outcome of the investigation under discussion. He had expected that the ration with a liberal supply of protein would cause a more generous development and proportion of muscular tissue than the other ration generally regarded as somewhat deficient in protein, and that the latter ration would produce animals relatively richer in fat. This expectation is not realized. While the protein-rich ration did for a time cause more growth than the other, we are unable to discover that it was different growth.

The flesh of the animals which ate the ration relatively poor in protein did not differ in general appearance from that of the other animals, and a chemical analysis does not show any essential difference in the proportions of protein and fats.

This investigation adds materially to the facts previously known which go to show that the individual animal possesses a constitutional inertia which may not easily be overcome. It is, perhaps, only when we resort to extreme measures, that we are able to disturb the methods of growth to which the animal by breeding is committed. It appears that though the ration varies widely, an animal selects from it and assimilates, such materials as suit the needs and purposes of that particular organism, and that while the rate of production may be very much modified by the character of the ration, the kind of production, whether of meat or of milk, is chiefly

controlled by the constitutional habit, unless as before stated the conditions of nutrition are rendered very abnormal.

These remarks are not offered as a new or final conclusion, but rather as indicating a general law which the feeder must, and already practically does, recognize.

It is interesting, at least, to note two other points concerning which the preceding data give definite information.

These points are:

(1) The proportion of the actual growth of the animal which may ordinarily serve as human food and therefore is most valuable.

It is easy to ascertain this proportion in the case of these four steers, and this is given in the table which follows:

TABLE LVI.

PROPORTIONS OF NON-EDIBLE MATERIAL IN ENTIRE BODIES OF STEERS.

	Dry Matter.	Protein.	Fat.	Ash.
STEER 1.				
In entire body, exclusive of skin, pounds	298.5	127.6	138.2	32.7
In edible portion, including kidney fat, pounds	171.1	74.7	92.8	3.6
In non-edible portion, pounds	127.4	52.9	45.4	29.1
Per cent in non-edible portion	42.7	41.5	32.8	89.0
STEER 2.				
In entire body, exclusive of skin, pounds	475.0	167.9	255.0	52.02
Edible portion, including kidney fat, pounds	273.0	98.6	169.7	4.7
In non-edible portion, pounds	202.0	69.3	85.3	47.3
Per cent in non-edible portion	42 5	41.3	33.4	90.9
STEER 3.				
In entire body, exclusive of skin, pounds	449.6	161.4	237.6	50.6
Edible portion, including kidney fat, pounds	265.6	95.5	165.5	4.6
In non-edible portion, pounds	184.0	65 9	72.1	46.0
Per cent in non-edible portion	40.9	40.8	30.3	90.9
STEER 4.				
In entire body, exclusive of skin, pounds	294.7	120.3	138.8	35.5
Edible portion, including kidney fat, pounds	166.0	70.3	92.2	3.4
In non-edible portion, pounds	128.7	50.0	46.6	32.1
Per cent in non-edible portion	43.7	41.6	33.6	90.4

It seems that without taking into consideration the skin and hair, over forty per cent. of the dry matter of the animal body is rejected

as unfit for food, unless we allow for the use that is sometimes made of the heart, liver and portions of the large stomach.

If we include in the refuse (in the sense of use as food) the skin and the ordinary kitchen waste, we find that very nearly half of the dry matter in body of a fat steer is either wholly wasted or is used for less important and valuable purposes than serving as food for man.

This is in strong contrast to milk as an animal food product, none of which is necessarily rejected.

It has been stated that two of the steers were slaughtered and analyzed at the age of about twenty-two months, while the other pair was fed for ten months longer.

It appears from our analyses entirely probable that the four animals were practically alike in composition when of the same age. This being assumed, we are in a position to learn the composition of the growth during the last ten months of feeding of the older pair.

LVII.

COMPOSITION OF INCREASED GROWTH OF OLDER STEERS.

	In Fresh Material.		In Water-free Material.		
	Water.	Dry substance.	Protein.	Fat.	Ash.
Entire bodies, except skin.					
Two steers fed 27 months	1,072.9	924.6	329.3	492.6	102.6
Two steers fed 17 months	829.2	593.2	248.0	276.9	68.2
	243.7	331.4	81.3	215.7	34.4
Per cent composition younger steers	58.2	41.8	41.8	46.7	11.5
Per cent composition increase for next 10 mos.	42.4	57.6	24.5	65.1	10.4

These results accord in a general way with those reached by Lawes & Gilbert. Those investigators found that the increase in fattening an animal contained a much smaller proportion of water and a greatly larger proportion of fat than the entire body.

The increase in the later stages of growth is of very much the same character, two-thirds of this consisting of fat, whereas the bodies of the younger steers were less than half fat.

Summary.

(1) Beginning at the age of four to six months two pairs of steers were fed from seventeen to twenty-seven months on rations differing widely in their nutritive ratio, one ration having a ratio of 1:5.2

and the other, 1:9.7. One pair ate 1884 pounds of digestible protein in the same time the other pair ate 1070 pounds.

(2) One steer of each pair was slaughtered and analyzed at the end of seventeen months feeding, the remaining steers being fed for ten months longer, when they were killed and analyzed. The chemical analysis included the entire bodies, excepting the skin and the contents of the stomach and intestines.

(3) At the end of fifteen months feeding, the pair of steers fed on the ration richer in protein had gained 221 pounds of live weight more than the pair fed the ration less rich in protein. The later growth with two steers showed a difference in favor of the ration less rich in protein.

(4) The relative weights of organs and parts of the body was practically the same with the steers of the same age, independently of the ration.

(5) The kind of growth caused by the two rations, viz: the proportions of water, protein, fat and ash, was not materially different with the steers of the same size.

This is true whether we consider the entire bodies, the dressed carcasses or the edible portions of the carcasses.

With steers fed for the same time, the composition of the entire bodies, the proportion and composition of the carcasses, and the proportions and composition of the edible parts were practically alike.

(6) The older pair of steers, viz: those fed for ten months longer time, contained a smaller proportion of water and a larger proportion of fat than the younger animals.

(7) The older animals furnished five pounds per hundred more of water-free edible material than the younger animals. This is equivalent to a difference of twelve pounds of fresh, edible meat.

HORTICULTURAL DIVISION.

H. P. Gould, Assistant Horticulturist.

The work of this department during the past year has, in a general way, been a continuation of the investigations of previous years. Cultural methods of certain vegetables have received attention, though the dry weather seriously affected all garden vegetables, and on this account no report can be given on many of the experiments planned at the beginning of the season. Especially does this apply to our work with tomatoes and cauliflowers.

The number of varieties of small fruits growing in the station gardens has been considerably increased and new varieties are constantly being added.

I—NOTES ON POTATOES.

Fungiroid as a Preventive of Potato Rot.

Almost every year brings to light new insecticides and fungicides; some of these discoveries are of great value, while many of them are no better and often far inferior to the older and better known materials.

Quite recently there has been put upon the market a fungicide known commercially as "fungiroid." This article is manufactured by Leggett & Brother, New York, and is said by them to be a powdered Bordeaux mixture and a substitute for that fungicide as ordinarily prepared. So far as I am aware, its qualities have not been thoroughly tested. If fungiroid should prove to be equally as effective as Bordeaux mixture, its advantage over the latter would be its ease of application. This applies especially in the treatment of low-growing plants.

It has been proven many times, beyond a doubt, that "potato rot" or "late blight" can be held in check, if not entirely prevented by the use of Bordeaux mixture. In order to test the efficacy of fungiroid as a means of combating this disease, a plat of potatoes was treated in the following manner: The first row was sprayed with Bordeaux mixture; fungiroid was applied to the second, while the third was left untreated to serve as a check on the fungicides and so on throughout the plat—every third row in order receiving the treatment described above, making six rows sprayed with Bordeaux

mixture, six treated with fungiroid, and an equal number which received no treatment.

The first application of fungicides was made July 13; two other applications were subsequently made at intervals of about two weeks.

The following table gives a summary of each of the six rows:

BORDEAUX MIXTURE VS. FUNGIROID.

Treatment.	Total weight lbs.	Ratio of yield.	Weight of decayed tubers. lbs.	Per cent of decayed tubers.
Bordeaux	262¾	1.00	1.1	.4
Fungiroid	219	.83	18.7	8.5
Check	198¾	.75	20.3	10.2

Referring to the column, "ratio of yield," it will be observed that the total yield of the untreated rows was only seventy-five per cent. that of the rows sprayed with Bordeaux mixture, or an increase of twenty-five per cent. from the use of the Bordeaux; the total yield from the rows treated with fungiroid was eighty-three per cent. that of the rows sprayed with Bordeaux, or an increase of seventeen per cent. in favor of Bordeaux mixture over fungiroid.

The last column gives the per cent. of decayed tubers. The rows sprayed with Bordeaux mixture produced only .4 of one per cent. by weight of decayed tubers, while from the unsprayed rows over ten per cent. by weight of the tubers were decayed. The fungiroid seemed to have but little effect in preventing the decay.

The results do not promise the future for the fungiroid which had been hoped for it, yet we do not wish to draw final conclusions from this one season's trial.

Conclusion: Fungiroid may slightly increase the yield of potatoes but seems to be of very little value as a preventive of late blight.

II—NOTES ON SWEET CORN.

Every one who is at all familiar with the catalogue of the average seedsman is equally familiar with the high sounding and attractive description of varieties which most catalogues contain. We do not wish to infer that such descriptions are given for the purpose of deceiving, yet the fact remains that if one bases his anticipations on the descriptions which he finds, he is likely to be doomed to disappointment at the results which he obtains. While this condition of things does not exist in regard to the descriptions of corn to the extent that it does in regard to many other things, yet not a few of

the statements are misleading. Especially have we found this to be true as to statements concerning the date of maturity. Very often varieties described as "early" have proven so late as to be almost worthless, and several so called medium sorts have failed to mature at all. A plausible excuse may appear, however, for this apparent deception when we consider the fact that practically all of the seeds disseminated by the larger seed companies are produced in a climate where the growing season is considerably longer than in Maine.

The following table represents most concisely the more important points relative to the varieties grown the past season:

Variety.	Source of seed.	Date of first appearance of tassels.	Date of first appearance of silks.	Date of edible maturity.	No. days from planting to date of maturity.	Average length of ears—inches.	Average height of stalks—feet.
Best of All	H. W. Buckbee	July 24	Aug. 1	Sept. 2	95	...	7.0
Cory (White)	J. M. Thorburn & Co	July 12	July 24	Aug. 17	79	6.0	4.5
Crosby's Early	J. M. Thorburn & Co	July 20	Aug. 5	Sept. 2	95	....	6.0
Early Dawn	Johnson & Stokes	July 24	Aug. 7	Sept. 7	100	7.5	6.5
Early Sweet	D. M. Ferry & Co	July 24	Aug. 7	Sept.11	104	9.0	7.5
Early Sunrise	Iowa Seed Co.	July 12	July 26	Aug. 17	79	7.0	6.0
Early Vermont	A.W.Livingston's Sons,	July 12	July 26	Aug. 24	86	....	4.0
Eastman's Early	Eastman Seed Co	July 12	July 26	Aug. 17	79	....	4.0
Hance's Early	A.W.Livingston's Sons,	July 24	Aug. 10	Sept.11	104	7.5	6.5
Henderson Sugar	Peter Henderson & Co.	July 24	Aug. 7	Sept. 7	100	9.0	8.0
Hickox Hybrid	D. M. Ferry & Co.	July 17	Aug. 7	Sept. 7	100	9.0	7.0
Honey	Johnson & Stokes	July 24	Aug. 10	Sept. 7	100	8.0	8.0
Lackey's Early Sweet	J. J. H. Gregory & Son	July 12	July 26	Aug. 17	79	6.0	5.0
Livingston's Evergr'n,	A.W.Livingston's Sons,	July 24	Aug. 10	Sept.15	108	9.0	7.5
Melrose	J. M. Thorburn & Co	July 26	Aug. 7	Sept. 5	98	....	5.0
New England	D. M. Ferry & Co.	July 15	Aug. 1	Aug. 31	93	7.0	6.0
Perry's Hybrid	J. M. Thorburn & Co	July 20	Aug. 5	Sept. 7	100	8.0	6.5
Quincy Market	J. J. H. Gregory & Co	July 15	July 30	Aug. 26	88	...	5.0
Shaker's Early	A.W.Livingston's Sons,	July 24	Aug. 8	Sept.11	104	8.0	6.5
Stabler's Early	J. J. H. Gregory & Son.	July 29	.....	Sept.11	104	8.0	7.5
XX Sugar	W. H. Maule	July 24	Aug. 7	Sept.11	104	7.0	5.5
*Acme Evergreen	Iowa Seed Co	July 29	Aug. 19	.....	....	....	7.0
*Burlington Hybrid	A.W.Livingston's Sons,	July 29	Aug. 7	.....	...	....	7.0
*Country Gentleman	Johnson & Stokes	July 30	Aug. 17	.....	....	....	7.0
*Early Large 8-Rowed	A.W.Livingston's Sons,	July 27	Aug. 10	.....	...	....	8.0

* Did not reach edible maturity.

The varieties named above were all planted the last of May. The first killing frost was about the middle of September, so that in addition to the varieties which failed to reach edible maturity those which matured on or after Sept. 11, of which there were several, were of but very little value for table use, as the date of edible maturity given in column five refers to the day on which the first ear was found which had reached an edible condition; this date, in most cases, was several days before enough ears could be picked to test the varieties.

For several years past the Cory has been the standard of earliness, but in quality it is far from perfection. As may be observed by referring to the table, several varieties were grown the past season

which came to edible maturity on the same date as Cory—seventy-nine days from date of planting. The variety—Early Sunrise—seems worthy of special mention. The quality compares very favorably with that of most later varieties and it was the most prolific variety grown.

Of the varieties which failed to reach edible maturity, we would call attention to the Country Gentleman, from the fact that since its introduction several years ago, no variety has received more favorable comment than this one, but for this State it is of little value on account of its lateness. It may mature under the most favorable conditions although it has been grown here for the past three years and in no case has it reached an edible condition before frosts, when given ordinary field culture.

III—NOTES ON PEAS.

It is a well known fact that nearly all of the earliest varieties of peas are what are commonly known as "smooth" or "hard" peas; the poor quality of this type is equally well known. One of the aims of the introducer has been to secure a sort which should possess the qualities of the later or "wrinkled" varieties and at the same time be as early as the smooth varieties. Efforts in this direction have been at least partially rewarded with success. There have been put upon the market during the past few years several varieties of the wrinkled type which are of excellent quality and also very early.

Our usual rate of seeding has been one quart of seed to 100 feet of drill, though it is probable that one quart to 75 or 80 feet of drill may be a more profitable rate.

The following descriptions are of "wrinkled" varieties of recent introduction which can be recommended for general cultivation.

Station, (Gregory): Of moderately vigorous growth; 5 to 6 peas to the pod; quality good; maturing in from 45 to 55 days.

Morning Star, (Childs): Growth somewhat less vigorous than Station; 5 to 6 peas to the pod; quality excellent; reaches edible maturity in 45 to 55 days.

Exonian, (Thorburn & Co.): Vines medium height but very small; foliage noticeably light colored; about 6 peas to the pod; maturing in from 50 to 60 days.

Early Woodside, (H. N. Smith): Of rather drawf habit; 6 peas to the pod; quality good; from 60 to 70 days required to reach edible maturity.

Climax, (Northrup, Braslan & Goodwin Co.): A very tall variety with rather small vines; one of the most prolific; quality not of the best; matures in about 70 days.

Echo, (Burpee): A moderately vigorous grower; 7 peas to the pod; matures in from 65 to 75 days.

Renown, (Burpee): Of rather drawf habit; prolific; season medium to late.

Nott's Excelsior, (Maule): A dwarf sort about 1 foot in height; 5 or 6 peas to the pod; matures in 50 to 55 days. Has received many favorable comments during the past 4 or 5 years.

The above are only a few of the many sorts which might be mentioned in the connection of "new varieties" but to increase the list woud be doubtless to increase the indecision if one were selecting varieties for planting.

In our comparison of varieties such well known sorts as American Wonder, Heroine, Stratagem, Telephone, Abundance, and several others of like reputation have been taken as the standard of excellence.

Of the smooth peas, we will simply make mention of the following varieties: Maud S., Sunol, Summit, Rural New Yorker, Alaska, Daniel O'Rourke Improved. These varieties have no marked distinctive characteristics aside from the type and their chief value lies in the earliness of maturity.

It will be observed that in the foregoing descriptions considerable latitude is given for the time required by the different varieties to reach edible maturity. This wide variation is given from the fact the season has considerable influence upon the time required to reach edible maturity, the number of days being less in a warm than in a cold season. The same difference is noticeable in the time required for the maturity of early and late sowed peas of the same variety.

IV—NOTES ON CABBAGES.

The attention given to cabbages during the past season, as heretofore, was confined chiefly to the study of different methods of culture. Several questions regarding the subject, which have previously received little if any attention, have been investigated.

The seed was all sown April 1st in the forcing house, and the plantlets pricked out into seed flats April 27th where they were allowed to remain until May 25th, when they were all set in the field.

The season was exceptionally dry and although the plants did not suffer from lack of moisture sufficiently to cause them to wilt yet they made a less vigorous growth and consequently smaller heads than would have been the case if there had been more rain.

1. Influence of size of seed. It has been thought by some that the amount of leaf surface relative to the size of the head, is influenced by the size of the seed, the supposition being that plants from large seeds run to leaf at the expense of the head, while with plants from small seed the tendency is the opposite.

That we might assertain, if possible, the accuracy of this view, three varieties of seed were chosen, from each variety of which were selected fifty of the largest seeds, also fifty of the smallest. The seeds were all sowed and when the plantlets were ready for the first handling, twenty of the best specimens from each lot were pricked out into seed flats and then treated as already described.

The comparative results are given in Table I.

TABLE I.

INFLUENCE OF SIZE OF SEED.

Variety.	Weight of 50 seeds—grams.	Heaviest head—pounds.	Lightest head—pounds.	Average weight—pounds.	Per cent of heads cracked.	Per cent of heads immature.	Per cent of plants not forming heads.	Ratio.
Harvest Home:								
Large seed.....	.339	9.1	2.1	6.1	7.7	15.4	23.1	.94
Small seed..... ...	.180	8.1	2.3	6.5	.0	.0	.0	1.00
Reynolds' Early:								
Large seed.....	.370	9.7	2.6	5.9	11.8	.0	5.9	1.37
Small seed.....	.169	6.9	2.1	4.3	9.1	18.2	27.3	1.00
Ballhead:								
Large seed.....	.319	8.5	3.6	5.9	.0	.0	.0	1.69
Small seed.....	.140	7.1	2.6	3.5	.0	.0	.0	1.00

The first column of figures gives the weight in grams of the various lots of seed. It will be observed that of the first variety, Harvest Home, the large seed weighed somewhat less than double that of the small seed while of the two other varieties, the large seed weighed more than twice as much as the small. The heaviest heads were produced by plants coming from the large seed while one of the smallest head was also produced by the large seed. In the case of the two last varieties referred to in the table, the smallest heads in comparison were from small seed. The figures relating to the maturity of the heads are so contradictory that no conclusions can be drawn regarding that point. The facts presented in the last column are perhaps the most striking and at the same time of the most value. These figures represent the ratio of the average weights of the heads compared. Representing the average weights of the heads from the small seed by 1, we find in case of the first variety that the average weight of the heads from the large seed is represented by .94. In other words, the large seed produced heads which averaged six per cent. less by weight than did those from the small seed. The average weights of the two other varieties,Reynolds Early and Ballhead, were 37 per cent. and 69 per cent. respectively in favor of the heads from large seed.

Deduction. It seems probable that the size of the seed has some influence upon the size of the head, the larger seeds as a rule,producing the larger heads.

2. Results of tying up the outer leaves. The idea has been entertained, that by binding the outer leaves together over the head

of the plant, maturity could be hastened. With this object in view, three lots of plants were treated accordingly as soon as the heads had commenced to form and corresponding lots were grown as checks.

The results, so far as represented by figures, are tabulated below.

TABLE II.

EFFECT OF BINDING OUTER LEAVES TOGETHER.

VARIETY.	Heaviest head—pounds.	Lightest head—pounds.	Average weight—pounds.	Per cent of heads cracked.	Per cent of heads immature.	Per cent of plants not forming heads.	Ratio.
Harvest Home.							
Outer leaves tied up	6.1	.8	3.0	26.7	.0	33.3	.44
Check	9.8	3.1	6.8	25.0	5.0	.0	1.00
Surehead.							
Outer leaves tied up	4.1	.8	2.6	14.3	.0	35.8	.46
Check	8.1	1.0	5.7	5.3	.0	5.3	1.00
Reynolds Early.							
Outer leaves tied up	4.9	.6	3.1	30.8	.0	53.8	.67
Check	9.9	2.1	4.6	47.1	5.9	17.6	1.00

The figures relative to the point in question reveal nothing from which we can infer that the operation has any influence upon the maturity of the heads.

By examining the table, however, it can readily be seen that the operation was not without its effects.

In next to the last column is found the percentage of plants from each lot which failed to form heads. Of the first variety, every check plant developed a head, while of the treated plants one-third failed to head; of the second variety, nearly the same proportion failed; while of the third variety, over one-half of the treated plants gave similar results, as did also about 17 per cent. of the check plants, making nearly the same difference between the percentage of plants failing to head in each comparison.

Again, the size of the head was greatly decreased by the treatment. The last column gives the relative weights of average heads. In two instances the average weight of the treated plants was less than one-half and in one case but little more than one-half that of the heads from the untreated plants.

Another result of tying up the outer leaves, which was even more noticeable than any yet mentioned, as the plants were growing in

the field, was the effect upon quality. The overlapping leaves did not effectually shut out the rain, yet when the moisture had once entered the spaces between the leaves, it was sufficiently inclosed to prevent a rapid evaporation. This continued dampness among the leaves very soon caused the outer portions of the heads to decay. As the season advanced, the decay extended both outward and inward, resulting in a large proportion of the leaves falling off a long time before the growth of the plants would otherwise have ceased. The result was that not a single marketable head was produced by the plants receiving the special treatment. Doubtless the premature falling of the leaves accounts in a measure at least for the decreased size of the heads.

Deduction. Tying up the outer leaves of the cabbage appears to have no influence upon the maturity of the heads, but it results in a marked decrease in the size of the heads and causes them to decay.

3. Effect of mulching: The value of straw or some similar material used as a mulch, in the conservation of soil moisture has often been discussed. Our experience in mulching tomatoes has already been reported.*

In order to ascertain, if possible, the effect of a similar treatment upon cabbages, several plants of three different varieties were given a mulch of swale hay, a sufficient amount being put on so that when packed down it should be two or three inches thick. It was applied after the plants had recovered from the check of being set in the field and growth had fairly begun. Three corresponding lots received frequent cultivation.

Table III is a statement of the results as represented by figures.

* Report Maine Experiment Station, 1894, p. 64.

TABLE III.

EFFECT OF MULCHING.

Variety and Treatment.	Heaviest head—pounds.	Lightest head—pounds.	Average weight—pounds.	Per cent of heads cracked.	Per cent of heads immature.	per cent of plants not forming heads.	Ratio.
Lupton:							
Mulched	9.5	2.8	6.0	5.3	.0	.0	1.00
Cultivated	8.9	1.5	6.0	31.3	12.5	6 2	1.00
Surehead:							
Mulched	9.1	2.6	6.1	5.9	11.8	.0	1.07
Cultivated	8.1	1.0	5.7	5.3	.0	5.3	1.00
Harvest Home:							
Mulched	11.2	3.6	7.7	21.1	15.8	.0	1.13
Cultivated	9·8	3.1	6.8	25.0	5.0	.0	1.00

The facts expressed in the above table are not at all conclusive. By referring to the figures relative to the maturity of the heads, it will be observed that of the first variety about five per cent of the mulched and thirty-one per cent. of the heads from the cultivated plants were cracked at the time of cutting. As the cracking occurs as a result of over maturity, the comparison last made,would of itself seem to indicate that the difference in results was due to the different treatment, but when studied in connection with other facts it loses its significance. This is shown in the case of the second variety which gave nearly the same percentage of cracked heads in both lots of plants. The difference between the two lots of the third variety was not great—less than three per cent. The sixth column gives the percentages of immature heads at the time of cutting. Of the first variety, all of the heads from the mulched plants were fully mature while about twelve per cent. of the cultivated were immature; in the second case, the conditions are just reversed; in the third case, the difference was nearly the same as in the former, but five per cent. of the heads from the cultivated plants were immature. Comparing the observations in the three instances, we find the greater number of immature heads were obtained from the mulched plants, while all of the plants which failed to head were from the cultivated lots.

The most uniform difference between the results of the two methods of culture was in the size of the heads. This difference was not striking, however, and may have been the result of other causes, though the conditions were as nearly uniform as possible aside from the special treatment given. The average weights of the Lupton

from both lots was the same; while of the Surehead and Harvest Home, the average weights were seven per cent. and thirteen per cent. respective greater from the mulched plants.

Deduction: Indications point to an advantageous use of a mulch in growing cabbages especially in a dry season.

4. SHALLOW CULTIVATION VS. DEEP CULTIVATION: The value of thorough cultivation has in recent years been greatly emphasized, though not unduly so, but as to just what is implied by thorough cultivation there may be a difference of opinion.

It has been our practice to use the cultivator with much freedom in the cultivation of nearly all garden vegetables and where the plants are set out carefully in straight rows the cultivator is usually run as close to the plants as possible without disturbing them. This becomes in many cases a method of root pruning. In order to determine, if possible, whether this method of cultivation has any specific effect upon the results obtained, twenty plants from each of four varieties were given the cultivation described above while four similar lots were given only such cultivation as could be furnished with a common hoe, though with the same frequency as the plants receiving deep cultivation.

The results are given in table IV.

TABLE IV.

SHALLOW VS. DEEP CULTIVATION.

VARIETY AND TREATMENT.	Heaviest head—pounds.	Lightest head—pounds.	Average weight—pounds.	Per cent of heads cracked.	Per cent of heads immature.	Per cent of plants not forming heads.	Ratio.
Harvest Home.							
Shallow cultivation	6.4	0.9	4.9	.0	52.6	5.3	.72
Deep cultivation	9.8	3.1	6.8	25.0	5.0		.01.00
Lupton.							
Shallow cultivation	7.9	1.6	5.6	15.8	5.3	5.3	.93
Deep cultivation	8.9	1.5	6.0	31.2	12.5		6.21.00
One-hundred Weight.							
Shallow cultivation	8.1	1.3	5.4	5.6	11.1		.01.12
Deep cultivation	6.8	3.2	4.8	.0	.0		16.71.00
Surehead.							
Shallow cultivation	10.0	3.0	6.6	5.3	10.5		.01.16
Deep cultivation	8.1	1.0	5.7	5.3	.0		5.31.00

Referring to the figures relating to the maturity of the different lots, it will be observed that of the first two varieties, the percentage of the cracked heads from the plants receiving deep cultivation was noticeably large, giving evidence of a greater maturity of the deeply cultivated plants; on the other hand the evidence of the third variety is contradictory and of the fourth, neutral. The difference in the percentages of immature heads gives evidence of the same fact; in three instances the proportion of immature heads was greater from the plants given shallow cultivation.

The effect of the different methods of culture did not seem to manifest itself in the size of the heads, as in two cases the results favor deep cultivation, while in the other two the larger heads were produced by the plants receiving shallow cultivation.

Deduction: Deep cultivation appears to hasten the maturity of the plants as evinced by the greater percentage of cracked heads from the deeply cultivated plants and by the greater percentage of immature heads from the plants given shallow cultivation. The size of the heads does not appear to be influenced by the different methods of culture.

VARIETIES.

Harvest Home: (Northrup, Braslan, Goodwin Co.) This is a late variety of good size, heads fairly solid, nearly spherical in shape.

Ballhead: (*Improved Danish Ballhead Winter*, James Vick's Sons). A rather small variety, shape nearly spherical, very hard and solid. Medium early.

Reynolds' Early: (Gregory). A medium early variety of good size, moderately firm and vigorous. Said to be the result of an artificial cross between the Scheweinfurt Quintal and Cannon Ball cabbage. This is a desirable variety for its season.

Lupton: (Maule). A sport form Excelsior Flat Dutch found in the fall of 1888. It forms a large, solid, flat head; plant strong and vigorous with a short stem. A very satisfactory variety for late use.

The other varieties mentioned above are satisfactory sorts but have no distinctive characteristics and require no special mention.

RECAPITULATION.

1. The size of the seed seems to have some influence upon the size of the head; the larger seed, as a rule, producing the larger head.

2. The tying up of the outer leaves appears to have no influence upon the maturity of the head, while it produces a marked decrease in the size and almost invariably causes the head to decay.

3. Mulching with straw or some similar material in a dry season tends to increase the size of the head.

4. Deep cultivation seems to have little if any effect upon the size of the head, but plants so treated appear to mature earlier and more uniformly than plants receiving shallow cultivation.

REPORT OF BOTANIST AND ENTOMOLOGIST.

Prof. F. L. Harvey.

Professor W. H. Jordan:

Dear Sir:—I have the honor to submit herewith my eighth annual report as botanist and entomologist for the experiment station.

The work of the season has been along the usual lines, embracing field work upon injurious plants and insects,laboratory investigations upon the life histories of insects and plants, preparation of material to illustrate lectures upon insects and weeds, lectures, preparation of articles for the press, correspondence and preparation of this annual report.

The most important field and laboratory work was upon the life history of *Trypeta* (*Epochra*) *Canadensis* (*Loew*) a fly doing much damage by stinging currants. This consumed considerable time during the summer months and the results of the study are given in the body of the report.

Boxes for storing specimens showing stages in the life history of a single insect, or small group of insects, have been made and the work of collecting and preparing specimens is in progress. These will be useful for comparison in study and determination of species and to illustrate talks upon insects before winter course students and farmers meetings.

A complete collection of weeds and forage plants is in process of preparation and will be useful for naming specimens sent for determination and to illustrate lectures.

Besides the local lectures to winter students in agriculture upon injurious insects and fungi, several appointments to lecture have been filled in various parts of the State; two for the Pomological Society at Presque Isle, two for the Board of Agriculture at West Rockport and Washington in Knox county, three at North Berwick, Saco and Cornish in York county; one at Turner Centre in Androscoggin county and one at North Jay, Franklin county, and two for granges at Fryeburg Centre and Monmouth. The subjects treated were Native Cranberries,Orchard and Farm Insects,Fungi and Weeds. At most points two subjects were considered.

An article upon Cattle Lice was written for the Lewiston Journal besides articles for other State papers, and also several papers of a technical nature upon the plants and animals of Maine were contributed to natural history journals.

As you are to sever your connection with the Maine Experiment Station at the close of the year I wish to thank you for the interest you have always taken in my work and for the liberal provision which has always been made to aid me in my investigatons and to express my regret thet such pleasant personal relations cannot continue.

Directions for Sending Specimens

will be found in the annual report of the Experiment Station, 1888, page 194 or in the Maine Agricultural Report 1888, page 158.

Correspondence.

It is the duty of the Station Botanist and Entomologist to answer questions regarding plants and insects that are of economic importance. Any citizen of Maine may avail himself of this privilege. Correspondence is therefore invited. We would particularly like to have farmers send us specimens of weeds they find in their fields as we wish to study the distribution of weeds in the State.

Below will be found notes upon the plants, and insects of importance that have claimed attention during the year. Those requiring detailed consideration are treated in the body of the Report. The usual tables of record of plants and insects are given below.

NOTES ON PLANTS.

Berteroa Incana, a cruciferous weed mentioned in our last report seems to have established itself, as specimens were received again this season. The various species of the mustard family are abundant in Maine.

The Dichotomous Catchfly, which was received from so many sources last year was not reported this season. Being an annual and such a coarse conspicuous plant the farmers probably cut it before seeding, and will have no further trouble with it.

The Common St. John's Wort, was received from South Rumford. This species is common in Maine, and is a pernicious weed. A perennial with a tough root. It is common in pastures, roadsides and thickets.

The Wild Carrot was found to be quite abundant in Knox county where it has become well established along neglected roadsides.

The Common Evening Primrose is quite abundant in various parts of Maine. It was considered in Board of Agricultural Crop Bulletin for August, 1895. Its large yellow flowers built on the plan of four and its size make it a conspicuous weed. It is not so common as the sundrops mentioned in our last report.

The Yellow Bed Straw was received for the first time the past season. It occurs as a weed in fields in Carroll.

THE CANADIAN GOLDEN-ROD is a common coarse species very abundant in fence corners and about pastures and thickets. It is usually associated with two or three golden-rods, asters and compositae.

THE CONE FLOWER OR YELLOW DAISY as it is called in Maine is distributed throughout the State. It was introduced with grass and clover seed from the West.

THE SCABROUS HAWKWEED a native species was received from several parties. It is related to the Orange Hawkweed, but is not nearly so bad a weed. The native species is found in open woods, thickets and grass lands. It has yellow blossoms and a leafy stem. The Orange Hawkweed has dark orange flowers.

THE GIANT LAURAL (*Rhododendron Maximum, L.*,) was received from Mr. C. S. Phinney of Standish. This is a rare species and the letter regarding it printed in the body of the report will be interesting.

THE CLOVER DODDER reported last season, seems to be abundant having been received this season from Kennebec, Penobscot and Piscataquis counties.

THE CREEPING THYME was reported for the first time. It is a weed belonging to the mint family.

THE ENGLISH PLANTAIN is still being shipped into the State in clover seed. It was found in two samples of seed examined the past season.

THE BLACK BINDWEED, a common twining plant belonging to the same family as the smartweeds, docks, sorrels and buckwheat, was received from Piscataquis county. It is a plant introduced from Europe, and the seed abundant in western oats.

BASTARD TOAD FLAX was reported from Sanford. It is not common in Maine. We have not seen it in Eastern Maine.

There has been no great damage done by fungi in the State the past season. The APPLE SCAB was more or less prevalent as usual. Not a single letter was received about other fungi. The dryness of the season would no doubt account for it.

NOTES ON INSECTS.

THE LONG-NOSED OX LOUSE was reported as very abundant on cattle in the vicinity of Thomaston, and from specimens sent by Mr. A. W. Batchelder, we were able to describe and figure the egg of this species which was not known before. This species is rare, the species found on cattle being more commonly the short-nosed louse, or sometimes the biting louse of cattle. An article upon cattle lice written for the *Lewiston Journal* is found in the body of the report.

THE WOOLLY-LOUSE OF THE APPLE was reported as feeding upon raspberries.

THE CHINCH BUG was found last August in a pasture in Moose River township about a mile from Jackman. The location was a sandy hillside. Quite large sports were infested. This species has been reported from Bethel about twenty-five miles north of Fryeburg. The new locality is fully 100 miles to the northeast.

THE YELLOW WOOLLY BEAR was reported as feeding upon raspberries. It has not been reported to the station before and therefore will be considered in this report.

THE APPLE-TREE TENT CATERPILLAR was received. This common insect should give no trouble as it is so easy to remove the egg clusters from the branches during the winter when the trees are leafless.

THE CLOTHES MOTH, (*Tinea Pelionella, L.,*) was found eating holes in carpets and shawls at Augusta.

THE MOURNING CLOAK BUTTERFLY did considerable damage to the foliage of elm trees about Waterville the past season.

THE CURRANT FLY, (*Trypeta* (*Epochra*) *Canadensis*) is doing considerable damage to currants in Maine. The fly stings the fruit and deposits an egg. The habits are much like those of the apple trypeta. This speces is considered, and illustrated in the body of the report.

Paoria Gilvipes, a small black beetle appearing the last of April or early in May, was reported as doing great damage by eating the buds on raspberry canes. Attention was called to this fact through the public print. In the body of the report the life history is given. This beetle is capable of doing much damage and has been a great nuisance to strawberry growers.

THE CUCUMBER FLEA BEETLE was reported as eating holes in petunia leaves. This is a common insect in early gardens feeding upon the leaves of radishes, cucumbers, squashes and potatoes. It is a small black beetle that has the power of jumping. There is a species of spring tail (*Smynthurus*) very common in Maine that has about the same habits as this beetle, and is liable to be mistaken for it. It is about the same size, jumps and eats small holes in the leaves. It should be called a garden flea, and may be distinguished by having long antennae and a forked jumping organ. It has never been described in the books.

THE LARDER OR BACON BEETLE is very abundant in Maine. The disgusting hairy larvae are well known to most house keepers. The insect is considered in the body of the report.

THE PEAR TREE SLUG continues to do some damage to the foliage of plum, pear and cherry trees. This insect was considered and figured in Station Report 1888, page 176.

THE GALL FLY (*Rhodites sp.*) In 1891 we found quite a number of moss like galls upon roses in the garden of Eben Webster, Orono, and reared from them the flies. Some of these were sent to Prof. Riley, who made the following reply:

"Your No. 3, is something of a puzzle. The gall is like that of the ordinary *Rhodites rosae*, but insect differs in the very important respect of totally lacking the parasidal sutures, a character which is at least of specific importance." We do not know whether the species was afterwards considered by Prof. Riley, nor what was done with the specimens. We did not study the insect further, and have not noticed the galls so abundant since. It is interesting to have the same galls reported from another locality, Mattawamkeag, Maine.

The black oak trees in Maine are often infested by a gall fly which produces large knotty excrescences on the branches, which are full of small holes after the insects have emerged. We have examined galls sent by Mr. Stover of Blue Hill, and find the species producing them is called by entomologists, *Callirhytis punctatus*, Bass.

The Horn-tailed Borer, a large species of saw fly that makes round holes about the size of a lead pencil in various trees was reported as laying its eggs in a maple tree.

The Apple Maggot, (*Trypeta Pomonella*) continues to be a great pest. It is spreading. Several parties have reported that by keeping the windfalls picked up or by keeping sheep in the orchard they have held it in check. As long as early apples are imported from Massachusetts, more or less infested with the larvae of this pest, our Maine towns will continue to be centres for the distribution of Trypeta.

The Buffalo Carpet Beetle seems to be spreading, having been reported as very abundant in Saco, South Litchfield and Bangor.

PLANTS EXAMINED IN 1895.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
1	.....	*Berteroa incana*, D. C	.....	Growing in grass lands. Introduced in 1893. Bad cruciferous weed.
2	Dichotomous Catchfly	*Silene dichotoma*, Ehrb.		
3	Long-leaved Chickweed	*Stellaria longifolia*, *Muhl.*	D. W. Lundray, Carroll	Growing in low grassy places.
4	Common St. John's-wort	*Hypericum perforatum*, L	T. H. Thornton, South Rumford	"A pernicious weed difficult to extirpate."
5	Lucerne. Alfalfa	*Medicago sativa*, L	E. P. Mayo, Waterville	Cultivated for fodder but spontaneous in fields. The specimens from Vassalboro.
6	Vetch	*Vicia Cracca*, L	G. G. Glover, Naples	Weed in mowing fields Bridgton. Native species but also found in Europe.
7	Cinquefoil	*Potentilla Norvegica*, L	.....	Considered in August Crop Bulletin.
8	Common Evening Primrose	*Œnothera biennis*, L	T. H. Thornton, South Rumford	The plants sent by Mr. Thornton were considered in August Crop Bulletin. A coarse biennial weed with large yellow flowers.
9	Wild Carrot	*Daucus carota*, L	E. E. Light, Union	Very abundant in Knox county about Union and Washington.
10	Yellow Bed Straw	*Galium verum*, L	D. W. Lundray, Carroll	Weed in fields. Introduced from Europe.
11	Canadian Golden-rod	*Solidago Canadensis*, L	T. H. Thornton, South Rumford	Weed along the border of fields and thickets. A native species.
12	Common Fleabane	*Erigeron Philadelphicus*, L.	T. H. Thornton, South Rumford	A common native weed. Perennial. Cultivation needed to eradicate it.
13	Called Yellow Daisy in Maine Cone Flower. Nigger-head elsewhere	*Rudbeckia hirta*, L	T. H. Thornton, South Rumford E. B. Haynes, Monson	A western species. Introduced in grass and clover seed from the West. Not abundant nor especially dangerous.
14	Scabrous Hawkweed	*Hieracium scabrum*, Mx	Several parties	A native species in open woods and pastures. Has yellow flowers. Not dangerous.

15	GREAT LAUREL	*Rhododendron maximum*, L	C. S. Phinney, Standish	Sent to be named. Rare in Maine. See letter in body of Report.
16	CLOVER DODDER	*Cuscuta Epithymum*, Murr	F. H. Parlin, East Winthrop I. N. Lapham, Pittston E. G. Lovejoy, Medford Center	A parasite upon red clover known by the fine yellow threads and clustered white flowers. Introduced from Europe.
17	CREEPING THYME	*Thymus serpyllum*, L	I. T. Merrill, China	A single bunch found on the farm. Not noticed before.
18	RIBGRASS. ENGLISH PLANTAIN.	*Plantago lanceolata*, L	J. H. Barton, West Windsor H. A. Sprague, Charlotte	Plant growing in fields. In sample of clover seed inspected.
19	WATER SMARTWEED	*Polygonum amphibium*, L	Abner T. Wing, Weld	Growing in bog hole from which muck had been taken.
20	BLACK BINDWEED	*Polygonum Convolvulus*, L	E. G. Lovejoy, Medford Center	Weed in fields.
21	BASTARD TOAD-FLAX	*Comandra Umbellata*, Nutt	O. H. Perkins, Sanford	Weed in field. Not common. Root parasitic on roots of trees.
22	REED CANARY GRASS	*Phalaris arundinacea*, L	D. W. Lundray, Carroll	Weed in fields. Native species which also grows in Europe.

INSECTS EXAMINED IN 1895.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
1	Long-nosed Ox Louse	*Hæmatopinus vitula*, L	A. W. Batchelder, Thomaston	Very abundant on cattle.
2	Woolly Louse of the Apple,	*Schizoneura lonigera* (Hausm.)	Dr. A. I. Harvey, Newport	Feeding on raspberry plants. (See Station Report 1890, p. 131.)
3	The Chinch Bug	*Blissus leucopterus*, Say	F. L. Harvey, Orono	Found in pastures near Jackman, Me., in August.
4	The Yellow Woolly Bear	*Spilosoma Virginica* (Fabr.)	M. B. Whiting	Feeding on raspberry leaves.
5	The Apple-tree Tent Caterpillar	*Clissiocampa Americana* (Harris)	E. G. Lovejoy, Medford Center.	Feeding on apple trees.
6	The Appleleaf Bucculatrix,	*Bucculatrix pomifoliella* (Clem.)	L. F. Abbott, Lewiston	Feeding on apple leaves in the vicinity of Wilton. (See Ex. Sta. Report 1893, p. 164.)
7	Clothes Moth	*Tinea tapetzella*, L	Mrs. Andrews, Augusta	Found eating holes in a shawl and carpet.
8	Mourning Cloak Butterfly,	*Euranessa antiopa*, L	E. P. Mayo, Waterville	Feeding on elms. (See Ex. Sta. Report 1888, p. 187.)
9	The Currant Fly	*Epochra Canadensis* (Loew.)	F. L. Harvey, Orono	Doing much damage to currants in Maine by stinging the fruit.
10	The Spotted Paria	*Paria gilvipes* (Def.)=*Typophorus canellus gilvipes* (Def.)	W. C. Symonds, North Norway C. L. Bray, Hebron	Attacking the buds on raspberry canes. Appearing the last of April or early in May.
11	The Cucumber Flea-beetle	*Crepidodera cucumeris* (Harris)	W. L. Mower, Greene	Attacking petunia leaves. Common in spring on cucumbers, radishes, potatoes, &c.
12	Larder or Bacon Beetle	*Dermestis lardarius*, L	Mrs. Albert Caswell, New Sharon	Found about rennet, old cheese and in bread closet.
13	The Pear-tree Slug	*Selandria cerasi* (Peck)	C. L. Duncan, Wells W. L. Mace, East Winthrop	Attacking leaves of plum, pear and cherry trees. (See Station Report 1888, p. 176.)
14	Rose Gall Fly	*Rhodites sp.* (probably new)	Stark Webster, Mattawamkeag,	Producing large mossy galls upon roses.
15	Oak Tree Gall.	*Callirhytis punctatus* (Bass.)	Austin Stover, Bluehill	Producing galls on oak trees.
16	The Horn-tail Borer	*Tremex columba*, L	Geo. P. Billings, Clinton	Depositing eggs in maple trees in which the larva live.

BOTANY.

Second Blooming of Pear Trees.

I have received from Hon. Samuel Libby of Orono, specimens of pear tree twigs in full bloom, taken from a pear tree in the orchard of R. H. Libby of Newport. We have also received recently from Aroostook county specimens of cherry twigs bearing bloom. The following facts regarding unusual and second blooming may be worthy of record.

It is a principle well known to botanists that the last effort of a plant is to reproduce itself. When a tree puts forth unusual bloom, or bloom out of season, it may be reasonably inferred that something is disturbing its normal functions or sapping its vitality. There are several causes, external and internal, that may produce this result.

(a) If a tree puts forth unusual bloom beyond what is normal and the tree shows no other signs of injury, it would be well to look for borers in the trunk or insects that feed on the roots.

(b) Fungi that attack the foliage, or injurious insects that feed upon the leaves may so check the growth of the annual shoots that the effort to reproduce will show itself the same season in late blooming.

This is the case with the pear tree in Mr. Libby's orchard. The blades of the leaves upon the twigs shown us, were almost entirely eaten by some unknown insect, the petioles and midribs only being left. The new shoots and flower buds were formed before the insect began its attack. The leaves were almost entirely eaten, the vitality of the tree checked, and the effort to reproduce caused the tree to put forth full bloom. The insect had done its work and gone into the ground to transform when attention was called to the tree by the late bloom.

Of course a tree suffers from such a shock and the bloom for the following season is destroyed, and without leaves the plant cannot elaborate food for present or future use and is quite liable to die. A few twigs may be affected by insects or fungi and the general vitality not impaired.

(c) Sometimes when growth is checked early in the season by drought and followed by a wet fall, plants take on a second or fall growth. They put forth the flowers in the fall that normally would not develop until the next season. Of course the following season would be a shy bearing year. Fall and spring growth is shown in the trunks of exogenous trees by two narrow rings which together about equal those of ordinary years.

Advantage is taken of the tendency of plants to reproduce when their vitality is checked to bring trees into early blooming. By put-

ting a stone in the crotch, or binding a limb with a cord, or even girdling a twig or trunk the vitality is checked and the tree brought into early bearing.

CATTLE LICE.

During the long Maine winters when snow on the ground prevents animals from finding dry earth to paw over themselves, they are apt to become lousy. Cattle lice breed rapidly. A single infested animal, if neglected, will before spring become literally alive, and by close contact in the stable and yard is almost certain to spread the parasites to the whole herd. These parasites are therefore more apt to give trouble during the winter. We have recently received specimens for examination, accompanied by a request for information as to the nature of the parasites, and how to destroy them. As there seems to be a demand for information we can better serve the many by preparing an article on these pests. The following article is designed to give information regarding lice in general, and to consider more in detail, three species that infest domestic cattle. Those wishing information regarding lice that affect other domestic animals will do well to procure a copy of Bulletin No. 7, Division of Entomology U. S. Department of Agriculture, from which the cuts to illustrate this article were taken.

General Consideration.

The term louse is derived from the same root as loss and loose, and is used in the sence of damager or destroyer and applies to quite a variety of degraded crustacean and insect parasites that do more or less damage to their hosts.

All of the lice belong to that branch of the animal kingdom called *Arthropoda* (jointed-footed animals) which embraces the crustaceans and insects. To the crustaceans belong the wood lice or sow bugs, non-parasitic, and feeding upon decaying organic matter and found in damp places. Some of their near relatives are true fish parasites and together with a large number of other degraded crustaceans, parasitic on fish, sea mammals and other crustaceans, are called fish lice. Certain mites (degraded spiders) are often called lice. To this group belong the red lice or harvest ticks, and the well-known itch louse or itch mite and others. These have eight legs.

The remainder of the lice are true insects (*Hexapods*) having six legs and belonging to several orders. Insects themselves are infested with minute lice. Those known as bee lice are degraded flies (*Diptera.*) Bees are also infested by minute lice belonging to the order *Coleoptera* (beetles.)

The bark lice, plant lice, and jumping plant lice are bugs (*Hemiptera.*) They are provided with beaks by means of which they suck the juices of plants. The sucking lice of animals, embracing the head

louse and body louse of man and a large number of other species parasitic upon domestic and wild animals, are also bugs and belong to the order *Hemiptera* (half-winged insects.)

The bird lice or biting lice include a large number of species of wingless parasites that infest birds and animals, and belong to the order *Pseudoneuroptera* (false nerve-winged insects.)

With the above general consideration we proceed to consider the lice of domestic cattle, two species of which belong to the sucking lice and a third belonging to the bird or biting lice.

SHORT-NOSED OX-LOUSE.

(*Haematopinus Eurysternus, Nitzsch.*)

ORDER HEMIPTRA; FAMILY PEDICULIDAE.

HISTORY.

This species has been known from the earliest times as a cattle louse though often confused with the next species. It was accurately described for the first time by Nitzsch in 1818. It has always been regarding as troublesome, causing a disease called *Phthiriasis*, demanding treatment.

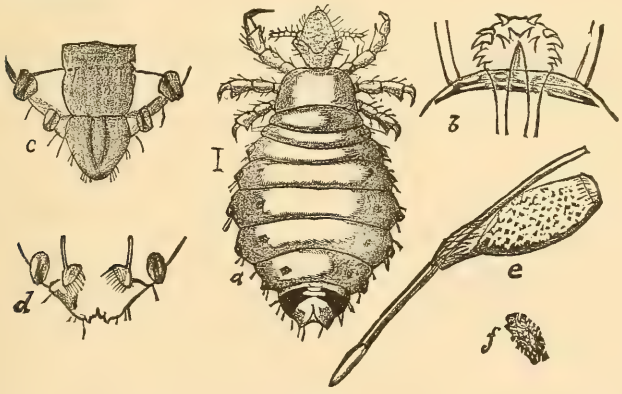


FIG. 1.

DESCRIPTION.

Females about one-eighth to one-half of an inch long and fully haif as wide. Head bluntly rounded in front, nearly as broad as long. Antennae on the middle and side of the head, five jointed. Eyes very small, located upon low eminences just back of the antennae, front of the head provided with an extensible beak, which is armed

with a double row of recurved hooks (See Fig. 1 b) by means of which the parasite is attached to the host. Also provided with a slender piercing tube by which blood is drawn from the host. Thorax broader than long, widest next to the abdomen. Legs, long, adapted for clasping. Basal joint of tarsus armed with a double plate bearing fine transverse ridges. Abdomen usually flat and flask-shaped, but variable according to degree of distention. A row of tubercles along each side, in which the spiracles (breathing pores) are located. Along each side of the upper surface a row of chitinous plates. There are two brush-like organs on the under surface of the next to the last abdominal segment, (See Fig. 1 d.) The upper surface of last abdominal segment black.

Males smaller and narrower than the females. There is a broad, black stripe upon the under surface running from the posterior end of the body forward to near the middle of the abdomen. (See Fig. 1 c.) The structure of the last segments of the abdomen of the sexes is quite distinct. (See Figs. 1, c and d.) The general color of both sexes is blue slate, though somewhat variable with sex, age and condition. The head and thorax are brown or yellowish. The tubercles at the sides and the chitinous plates chestnut.

Eggs minute, elongate, oval, tapering toward the base, which is attached by adhesive material to the hairs near the roots. Surface reticulate, the crossings armed with minute points. We do not know the time required to hatch, nor the number of eggs laid. The eggs are generally called *nits*. (See Fig. 1 e.)

The young escape from the upper end of the egg, which is provided with a cap-like lid. They are like the parents only smaller, and as they mature develop the chitinous plates.

LONG-NOSED OX LOUSE.

(*Haematopinus vitula, Linn-tenuirostris,* Burm.)

ORDER HEMIPTERA: FAMILY PEDICULIDAE.

HISTORY.

In connection with the previous species, this louse has long been known to cattle men and entomologists, though often confused with it, as both are often found parasitic upon the same animal. The specimens we have received this winter have all been of this species.

DESCRIPTION.

About one-eighth of an inch long and not more than one-third as wide. (See Fig. 2.) The head oblong, nearly four times as long as wide, and widest in the middle, just behind the antennae, set well

back into a groove of the thorax and acute behind. Antennae five-jointed, located on the middle and side and usually extending forward. Thorax nearly twice as long as wide, with a breathing pore on the upper side opposite each of the second pair of legs. Abdomen oblong, wih nine segments. Devoid of chitinous plates or tubercles at the sides. Clothed, apparently, with small teeth, the outer row giving the edge of the body a finely dentate appearance. The terminal segment bilobed behind, each angle armed with about five rather long hairs. The two or three preceding segments bearing, on each side, two quite long hairs. The under side of the next to the last abdominal segment bears two brush-like organs. (See Fig. 2.) General color, bluish gray in adults. The life history of this species is much like that of the preceding species, though the details are no better known.

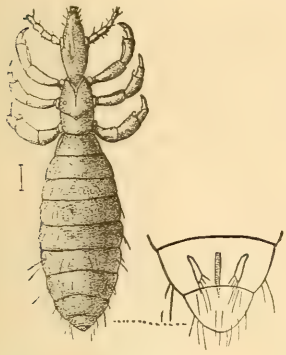


FIG. 2.

BITING LOUSE OF CATTLE.

(*Trichodectes scalaris*, Nitzsch.)

ORDER PSEUDONEUROPTERA: FAMILY PHILOPTERIDAE.

GENERAL CONSIDERATION.

This species of louse belongs to what are usually called bird lice (Mallophagans.) They are provided with mouth parts adapted for biting. They infest birds and animals, feeding upon the hairs, feathers, epidermal scales and waste products of the body of their hosts. They are said to have a suctorial organ and probably at times feed upon the blood. They are wingless, one family (Philopteridae) having the legs adapted for clasping and another family (Liotheidae) adapted for running. The bodies are usually horny and much flattened. The species are so numerous that there is scarcely a bird but what harbors one or more kinds. Some regard them as essential to the health of the host, that is, mutuals. They probably cleanse and beautify the feathers and remove wastes from the body. They injure animals less seriously than the true suctorial lice, as their principal food is wastes of the body. In great numbers, especially upon tender skinned animals, they are a source of much irritation, causing the animals to grow poor and lack vigor.

History and Distribution.

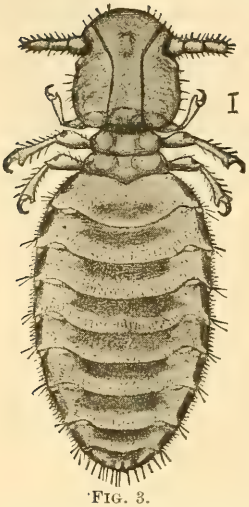


Fig. 3.

Abundant the world over upon cattle. First described by Linnaeus as *Pediculus bovis*. The present name was given it some time later and is adopted regardless of priority. The species is one of the best known animal parasites.

Description.

About one-twelfth of an inch long and of the form shown in Fig. 3. The antennae have only three joints, while the most of the bird lice have five joints to the antennae. There are dark bands across the abdomen as shown in Fig. 3. On account of the size and color they are called "little red lice" to distinguish them from the larger sucking lice that infest cattle and popularly named "blue lice." They are naturally more abundant in the spring. The eggs are attached to the hair and the young resemble in form the adults. Nothing is known regarding the number of eggs laid, the time required for them to hatch, or the time it takes them to mature, or the length of life. Here is an opportunity for some entomologist to distinguish himself, by tracing the life history of this and other species of cattle lice.

Remedies.

Lice irritate the skin. When animals are found rubbing they should be examined at once. If lice are found, separate the infested animals. Search about the neck and shoulders, at the base of the horns, around the eyes and nostrils, and along the back. Separate the hair and expose the skin. If lice are present they can generally be detected. A fine toothed comb could be used in searching. Infested animals are generally restless. When badly infested they lose flesh and the coat is staring. Bare places from rubbing appear on the neck and shoulders. It would be well to examine animals when they are put into winter quarters and not wait for pronounced cases before adopting remedial measures.

The authorized remedies for lice naturally divide themselves into four classes, viz: powders, unctions, liquids and fumes.

The powders usually employed are pyrethrum, ashes or road dust.

The unctions, mercurial ointment, and a mixture of kerosene and lard.

The liquids, decoctions of tobacco, stavesacre, or the seeds of the common larkspur; solution of carbolic acid soap, or kerosene emulsion. The fumes, burning tobacco, sulphur, or phyrethum.

Pyrethrum or Persian Insect Powder should be blown into the hair by means of a small pair of hand bellows until it is well filled. Ashes could be applied in the same way or sifted over the animal and rubbed in with the hand. Dry fine road dust can be used, and like ashes probably acts by stopping the spiracles of the parasite. This last seems to be nature's remedy, as animals will throw dirt over themselves when they have access to it . The unctions should be applied about the eyes, nostrils, base of horns, upon the neck and shoulders, and along the back. The decoctions are not practical remedies during the winter, unless the animals are kept in a warm room during treatment. The liquid remedies are probably the best and should be rsorted to when possible, especially in bad cases. The animals should be wet with the solution. Care should be taken that the solution is not too strong, and keep it out of the animal's eyes. The kerosene emulsion should be considerably diluted. The animals could be carded with a brush dipped in kerosene oil and the lice much reduced or destroyed.

Fumigation of the animals is sometimes resorted to, but it requires a tight box stall with a door behind and a wood stanchion in front. A canvas covering is made to fit tightly over the head of the animal, leaving only the eyes and nose exposed, while the other end of the canvas is tacked to the stall. Into this compartment through an opening, the burning tobacco, sulphur or pyrethrum is introduced. The time of exposure would vary with the strength of the fumes. Prof. Osborn found that the fumes from two ounces of tobacco and a half hour exposure was sufficient. Pyrethrum would probably do equally as well or better. The tobacco or pyrethrum could be burnt upon a piece of sheet iron heated by a small kerosene oil stove. r

EGGS OF THE LONG-NOSED OX-LOUSE.

Haematopinus Vitula, L.

After writing the article upon cattle lice we received from Mr. Batchelder specimens of hair with the eggs of the above species attached. As the egg had never been described and figured, we prepared the following account which appeared in Psyche, June 1895, but it should be put on record in the Station Report.

Professor Osborn says in his monograph "Pedicula and Mallophaga affecting Man and the Lower Animals" (Bull. 7, Div. Ent. U. S. Dept. Agric. p. 18) "that the eggs of this species have not been described, and we have not had the good fortune to discover them." Having been more fortunate we are able to submit the following account of the eggs of this species. The Long-nosed ox-louse has been quite bad this winter in herds in the vicinity of Thomaston, Maine. At our request Mr. A. W. Batchelder of Thomaston collected some hair from the infested animals, and upon this we found *three egg-shells* with the operculum off, but the form, sculpture, manner and place of attachment to the hairs seemed perfect.

Description.

Elongate oval, tapering toward the base. Slightly bulging on the side away from the hair in one specimen, or in the others narrower and more symmetrical. About two and a half times as long as wide. The empty shell hyaline and *beautifully sculptured with hexagonal reticulations.* The hexagons somewhat variable in size and perfectness in different parts of the shell, but average ones about one-twentieth of the width of the shell. The surface apparently smooth, the angles of the reticulations not beset with points as in the eggs of the Short-nosed ox-louse. Attached to the hair by a cement mass about one-third the length of the egg, as shown in the figure. The cement mass varies in shape, the distance it extends along the hair and the remoteness of the attachment from the root of the hair. The sloping base of the eggs is included more or less in the cement mass, and the eggs stands somewhat obliquely outward from the hair.

Fig. 4.

Below we give measurements of the three eggs observed. The figure, drawn to scale by the writer, shows the egg enlarged 40 times.

Measurements.

Specimen (*a*,) length, .863 mm.; width, .38 mm.; width of operculum, .265mm.; from base of hair, 5 mm.; cement mass, .345 mm.; hexagonal reticulations of shell, .02 mm.

Specimen (*b*,) length, .805 mm.; width, .379.; width of operculum, .253 mm.; from base of hair, 5.75 mm.; cement mass, .288 mm.

Specimen (*c*,) length, .805 mm.; width, .379 mm.; width of operculum, .265 mm.; from base of hair, 10 mm.; cement mass, .312 mm.

THE YELLOW WOOLLY-BEAR.

Spilosoma Virginica (Fabr.)

Order. Lepidoptera. Family Arctidae.

This insect was reported the past season as feeding on raspberry leaves. Though more commonly found on grapes it feeds upon various plants. The eggs are deposited in clusters on the under side of the leaves.

The young larvae feed in company for a time, but finely separate each going its way.

When full grown the larva is about two inches long and usually yellow, but sometimes straw color or brown. The segments are

armed with yellowish tubercles which bear tufts of yellowish or brownish hairs. When ready to transform the hairs are woven with silk into a cocoon. The perfect insect called "The White Miller" appears in April or May. It expands nearly two inches and is pure white with a few black spots.

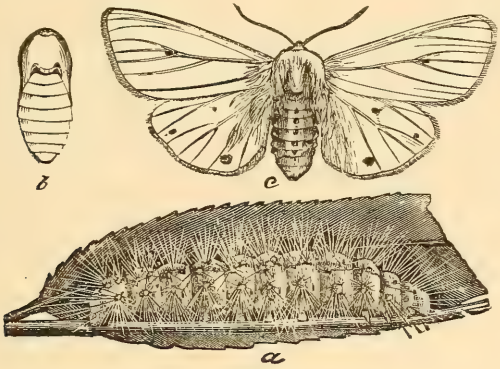


FIG. 5.

REMEDIES.

Hand-picking is the best method to keep them in check. The best time to destroy them is while the young are feeding in company and before much damage to the foliage is done.

THE TAPESTRY MOTH.

Tinea Tapetzella, L.

ORDER LEPIDOPTERA. FAMILY TINEIDAE.

A specimen of the above named cloths moth was received from Mrs. Andrews of Augusta. It was reported as eating holes in a carpet and a shawl. This is the rarest clothes moth found in Maine. Besides the above species that makes channels through cloth in which it works and does not make a case out of the fragment of the cloth, are two others which are quite common, viz: *Tinea pelionella*, L., which make little cases out of the cloth fragments in which it works, and *Tinea biselliella*, which spins a cocoon found under the infected carpet.

The above mentioned species on account of its rarety is not likely to become much of a pest.

THE SPOTTED PARIA. STRAWBERRY LEAF BEETLE.

Typophrus Canellus, Fabr. var. gilvipes, Dej.

ORDER COLEOPTERA. FAMILY CHRYSOMELIDAE.

We received the following letter, No. 1, from Mr. Bray, accompanied by specimens, which we carefully examined and named as above.

We wrote him to spray with Paris green at once, and also asked a number of questions stating that this insect had been known as a great pest to strawberry growers in other states, but had not before been reported as injurous to the strawberry or raspberry in Maine. In letters No. 2 and 3 will be found the reply. After reciving Mr. Bray's second letter, to be sure that we were right, specimens were submitted to Dr. Horn and Mr. Henshaw both specialists in Coleoptera, and they confirmed the name. The fact that this insect has done no damage to strawberries in Maine, and should take to raspberries and blackberries is somewhat remarkable. It is also strange that it should appear in noticeable numbers so suddenly. Below is given an account of the insect.

HEBRON, MAINE, April 30, 1895.

Professor Jordan:

DEAR SIR—I send you some raspberry canes and a few of the insects that are eating them. I have one acre of Cuthbert raspberries and they are covered with the insect enclosed. They eat into the buds as shown on the canes sent, and I fear will ruin the crop. I had a few of the same last year. They do not seem to fly around, but crawl up the canes from the ground. I shall try spraying with "Paris green", four ounces to fifty gallons of water, but do not have much faith that it will do any good. I think there will have to be something used on the canes that they will not like the smell of to prevent their crawling up. Please tell me what they are and what remedies I had better try.

Respectfully yours,
C. L. BRAY,
Hebron, Maine.

HEBRON, MAINE, May 14, 1895.

Mr. Harvey:

DEAR SIR—Yours at hand and in reply will say that I fear you have got the wrong insect. I have raised all kinds of small fruits for the past ten years including strawberries and have never noticed the insect before last year, and then only on raspberries. I got my first raspberry plants about ten years ago from A. M. Purdy, Palmyra, N. Y., and have increased my patch to one acre from them. I have sold plants to different parties and fail to hear of any injury being done to any of them with one exception. Last year was the first time I ever saw any of the insects, and where I raised in 1893, 80 bushels of berries I got only 30 in 1894. I sold about 1300 plants last

year, but fail to find that the insect was seen on any of them after leaving me either last year or this. I have never seen any grubs in the ground except the large white grub that infests grass and strawberries. They are very numerous and I have about given up raising strawberries on account of them. There is hardly a green leaf on my whole acre, neither are there any sprouts coming up. They seem to be eaten off as soon as they break through the ground. They appeared in large numbers as early as April 15th or 20th, and damaged them so before I noticed them that I got discouraged and have not tried to do much with them. I put on about 30 bushels of wood ashes to the acre, and think that it checked them one-half or more until we had a rain when they seemed to be thicker than ever. They do not jump, but the least touch of the bushes or in walking through them talking or making much noise they will curl up and drop to the ground as though they could see or hear. I noticed they began mating about May first, but at this writing they have about all disappeared. About your questions will say:

First. They began mating about May 1st. I first noticed them about April 15th or 20th.

Second. I have never seen them jump and do not think they do.

Third. I saw them first in the spring of 1894, they were quite plentiful and did much damage.

Fourth. I have grown strawberries, but never saw them infested with this insect.

Fifth. I bought 100 plants from New York ten years ago, and and have increased my patch from them. Have sold a great many plants to different parties, but fail to hear of them being infested on any of them with one exception.

Sixth. I have never noticed any white grubs about the roots. Any further information that I can give you will be cheerfully given, as I want to be prepared to fight them next spring.

Yours truly,
C. L. BRAY,
Hebron, Maine.

Thinking it desirable to find out how widely this pest was distributed in the State, we put the following letter into the Bangor, Lewiston and Augusta papers.

ORONO, Me., May 13, 1895.

We desire to call attention through the columns of the Journal to a small black beetle about one-eighth inch long that is reported as climbing up raspberry canes and eating the opening buds. This is one of the worst pests to the strawberry grower, and should not be neglected.

These beetles hybernate and come out early in the spring doing great damage to the flower buds. They soon mate and lay eggs for a second brood. The grubs live in the roots of the plant and later appear as beetles and in the summer devour the foliage. Those killed now will prevent the increase.

The canes should be sprayed at once with Paris green, one pound to 200 gallons of water, or one pound of fresh white helebore to 50 gallons of water. To ascertain whether this beetle is common in the State and also to learn whether it has been known to feed upon raspberry plants, we would be pleased to hear from any one who has observed it; to make the matter certain, a few of the beetles and a cane with the buds injured should be sent in a wooden box, or, if working on strawberry leaves, the beetles only need be sent.

F. L. HARVEY, Entomologist,
Experiment Station.

In response to the above notice we received the following letter and a package of the above named beetle.

NORTH NORWAY, Me., May 16, 1896.

DEAR SIR—Noticing your communication to the Lewiston Journal in regard to the raspberry flea-beetle, will say, that a small brown jumping beetle, hard to catch, has done considerable damage to my half acre of Shaffer raspberries. Have not seen them on strawberries, but have seen them on blackberries, but they did but little damage. They are especially injurious to raspberries that leave out late. I have collected a few of the insects and mail them. They are not a jumping animal, but fall and play dead on being disturbed.

Yours truly,
W. C. SYMONDS.

Below we give letters received this spring just as we are completing our report and insert them as additional information upon this pest.

HEBRON, Me., May 12, 1896.

Prof. F. L. Harvey:

DEAR SIR—The bugs came on to my raspberries about April 20th, and it has been a fight between us two which would win, but it now looks, as you will see by the canes sent, as though the bugs would conquer. I have never raised but a very few strawberries and have never seen any of the bugs on them. Last year I looked the few vines I had over very carefully, but failed to find any of them. I have sprayed the most of the piece with Paris green, one to fifty gallons water, but can see no difference, and doubt very much if it will do any good as they take the bud before it begins to open and eat the inside all out, so you see it would be a difficult job to get the poison where they would get it. The only way that I can see is by hand killing. I have never seen any of the bugs jump, but they will roll off the bushes as soon as disturbed. I also send you a bug that is longer and lighter colored. (There seems to be two colors of the bug I sent you last year. One a shiny black, and the other a little reddish, perhaps male and female.) I find them quite plenty on the raspberry bushes that have got some leaves. The black bugs eat the sprouts in the ground, as you will see by the root sent.

Very truly,
C. L. BRAY.

NORTH NORWAY, Me., May 5, 1896.

Mr. F. L. Harvey:

DEAR SIR—The beetles referred to have appeared in large numbers. They can be seen flying on warm days near the patch. They attack everything in the shape of raspberries and blackberries, wild or cultivated. They have never yet done the blackberries much harm, seeming to prefer the blackcaps. They do not molest the strawberries close by. I did not spray last season. I have not noticed a second brood.

Yours truly,
W. C. SYMONDS.

HISTORY.

This insect was first reported injurious to strawberries in Canada, as early as 1873. Since then it has done considerable damage to strawberries. The larvae working in the roots and crown of the plant and the beetles eating the foliage. It is a general feeder (polyphagous) being known to feed upon juniper, walnut, hickory, black locust, hypericum, solidago, etc. Prof. Forbes reports it feeding upon raspberry leaves in 1884, but does not say it did serious damage. The cases referred to above would seem to be the first instances of great damage being done to raspberries and so far as we know, injury to the buds early in the season has not been reported. So far as we know it has never before been found feeding on blackberries. It has never been reported to the Station as doing injury to strawberries in Maine. That it should first appear in injurious numbers upon an unusual food plant is strange. The larvae have hitherto only been found in strawberry roots. It will be interesting to learn whether the raspberries were near strawberry patches, and whether the larvae attack the roots of raspberries and blackberries. The following description of the larva and pupa we take from Prof. Forbes' account, as we have not had them for study.

DESCRIPTION.

Larva—"White, 3 to 4 mm.; (.12 to .16 in.) long, and half as wide. The head and first segment pale yellowish brown." We have never seen larvae taken in Maine.


FIG. 6.

Pupa—"White except the eyes and mandibles which show red or black through the pupa skin. The head is bent against the breast and the legs folded against the body beneath."

Perfect Insect a small beetle about one-eighth of an inch long, usually polished black. The wing covers marked with longitudinal rows of pits. The thorax irregularly pitted with smaller depressions than those on the wings. The body stout. The legs brown.

Mr. Saunders says this insect is about three-tenths of an inch long. Out of sixteen specimens measured none exceeded 3.5 mm., and most were only 3 mm. or about one-eighth inch long.

He says: "pale in color—sometimes dark" having the wing covers spotted with black. Out of sixteen we mounted at random all are entirely black on the wing covers excepting one which had brownish elytra bearing *four* black stripes, two on each wing cover as shown in Mr. Saunders figure which we give above. We would think the reverse of Mr. Saunders' statement—usually black, sometimes pale—would be more nearly correct. Prof. Forbes in his Second Report, page 161, says: "In the lighter specimens the ventral segments and *three* spots on each elytron are black. Whether these variations in color are due to age, sex or food we do not know. It is evident that some careful work is still needed upon the habits and transformations of this insect. The eggs so far as we know are not known, nor the place of deposition. It is probable that these beetles hybernote, and the pupa that spring, but spent the winter in the beetle form about the roots of the plant.

Remedies.

Should the beetles crawl up the canes before the buds start or after the leaves unfold and before the fruit is formed spraying with Paris green would prove effectual.

Should they appear after the leaves and fruit are formed, as is usually the case, then it would be unsafe to use Paris green, and hellebore would have to be used.

Mr. Bray's experience would indicate that Paris green is not efficient. Certainly one pound to fifty gallons ought to kill them. A repellant or an insecticide that would injure the insect would have to be applied.

As the beetles probably hybernate it would be well to clean up all rubbish about the canes that would afford them winter shelter.

Hand picking though slow may have to be resorted to to check them.

THE CUCUMBER FLEA-BEETLE.

Crepidodera cucumeris, Harris.

Order Coleoptera. Family Chrysomelidae.

A small black beetle about one-sixteenth of an inch long. The antennae and legs are yellow. The hind pair large and strong and adapted for jumping. Very abundant in Maine, early in the spring upon various garden plants, eating small holes in the leaves. It was reported as feeding upon petunias. The beetles spent the winter under rubbish or stones and are ready to attack the earliest plants. The larvae are said to live on the leaves attacked. There are several broods during the summer. The beetle enlarged is shown in Fig. 7. The short line at the left shows the real size.

Fig. 7.

Remedies.

Sprinkle the leaves with hellebore powder or Paris green mixed with fifty parts of flour or plaster. Air-slaked lime or even ashes are said to be good remedies.

THE CURRANT FLY. GOOSEBERRY FRUIT FLY.

Epochra Canadensis, Loew.

Order Diptera: Family Trypetidae.

Bibliography.

Loew—In Smith. Miss. Colls. 256. Monographs of the Diptera of North America Pt. III, p. 235, December 1873. Original description under the name *Trypeta Canadensis*, n. sp. from a Canadian or Maine specimen. *Epochra* is suggested as the more proper generic name.

The female is described, evidently from a single faded imperfect specimen. Habits not stated.

Saunders—Insects injurious to fruits, 1883, p. 352. "This insect is occasionally found attacking the fruit of both the red and the white currant. In its perfect state it is a small two-winged fly, which lays its eggs on the currants while they are small; the larva enters them while still green, and feeds on their contents, leaving a round, black scar at the point of entry. The affected currants ripen prematurely, and shortly decay and drop to the ground, when on opening them, there wil be found in each a small white grub, about one-third of an inch long, which when mature leaves the currant and probably passes the chrysalis state under the ground." The above is a full statement of Saunders' remarks in Insects Injurious to Fruits, p. 352.

Gillette, C. P.—Colorado Experiment Station, Bulletin No. 19, p. 18, May 1892. Account of its attacking gooseberries in Colorado. That the fly punctures the skin by a sharp ovipositor. The eggs were observed under the skin. The flies noticed ovipositing. The berries soon turn red and drop after being stung and the maggots remain in them for some time after they fall to the ground. The flies captured and identified. But one brood. Gathering the fallen infested berries suggested as a remedy.

Editors Insect Life. Injurious Insects of 1891 in Colorado. Review of above Bulletin, No. 19. Mere mention of the Gooseberry Fruit Fly (*Epochra Canadensis*, Loew.)

Snow, W. A.—Kans. Univ. Quar., Vol. 11, No. 3, 1894, p. 159. "One male (Maine) in poor preservation apparently belongs here. The wing agrees with the description; the stature of the body can hardly be called "short and rather broad;" the scutellum has four bristles.

Loew was in doubt whether the normal number of bristles on the scutellum was four or six. The reddish abdomen is black at the base and on the two distal segments, but this coloring has much the appearance of being the result of dessication." The above is a full statement of Prof. Snow's remarks, which we insert because they may not be readily accessible, and because we refer to them under *Critical remarks.*

History and Distribution.

This species was first considered by Loew in 1873, from a single faded female contributed by Osten Sacken. Osten Sacken's material may have come from Maine, as he gives Norway, Maine, as the locality, the specimens having been collected by S. J. Smith. Loew gives Canada as a locality upon the authority of Mr. Provancher. How long the species had been known before it was described does not appear, but Osten Sacken says it "seems to be common in those regions." If its habit of infesting currants was known in 1873, no mention is made of it. It is next considered by Saunders in 1883. During the intervening ten years its currant infesting habit became known and some attempts were made to determine its life history.

In 1891, Prof. Gillette found it very abundant in Colorado, infesting gooseberries. This being the first authentic account of its infesting that fruit. Prof. Gillette also added many facts regarding the life history as given above.

Prof. Snow in 1894 examined a single male and contributes the fact, that the bristles on the scutellum are four.

Regarding the single male specimens considered by Prof. Snow, (See bibliography above) he gives us the following: "My single specimen of *Epochra Canadensis* is from the Yale collection and I found it among Dr. Willeston's flies. There is no label upon it except "Me." and Dr. W. can give me no farther information."

We find no reference to this insect in the Agricultural and Horticultural Reports of Maine, and if it has done injury heretofore it has not been recorded.

Mr. Z. A. Gilbert says he was formerly troubled by such an insect, but stopped growing currants for a time and then resumed and has not been troubled since. Mr. D. H. Knowlton, Farmington, says his currants have been infested for several years.

Our first knowledge of this insect was in the summer of 1894, when Prof. Jordan called attention to the fact that a large number of the currants in his garden in Orono was dropping, and that the fallen fruits each contained one or more white maggots. The only reference found to such a currant insect was the few words regarding *Epochra Canadensis*, Loew, in Saunders Fruit Insects, p. 352.

The serious nature of the injury being a matter of importance, and the fact that the life history was apparently almost entirely unknown led us to seriously begin the study of its habits. We were

strengthened in this resolution after finding that the description given by Loew was drawn up from a single female. We did not then know of Prof. Gillett's observations, which are accurate in the main but general, and we trust the more detailed study we have made will be helpful. We were interested in comparing the life history of this insect with *Trypeta pomonella*, Walsh, which we studied in 1888-9. The experience gained in the study of that insect has aided us very much in the study of this. We studied the larvae and pupae in the summer of 1894, and in the spring of 1895 considered the flies, their eggs, and the method of ovipositing, completing the life history. The following results of our study are humbly given hoping they may contribute to a better knowledge of this injurious insect.

The following data which probably refers to *Epochra Canadensis* lacks sufficient confirmation.

Mr. L. O. Howard informs us that in the notes of the Division of Entomology at Washington are the following facts: "June 15, 1885, package of currants and gooseberries infested with larvae evidently of *T. Canadensis* was received from G. L. Colfax, Washington (State.) The adults were not reared. "July 11, 1892, package of gooseberries infested by what is evidently the same insect was received from D. Thurston, West Ferndale, Washington (State.) The larvae were dead when received.

To gain farther information we addressed a letter to Mr. Thurston and received the following reply.

West Ferndale, Whatcom Co., Wash., July 7, 1895.

Prof. Francis L. Harvey, Orono, Maine.

Dear Sir—Yours of July 1st to hand. During the years 1890, '91, '92, I noticed my currants (black, white and red,) also gooseberries badly troubled with the worm you refer to. In '93 I was at the World's Fair and could make no observations. In '94 I did not notice any, (my attention not being specially directed to the subject.) This season, '95, at your request I have just looked over my small fruit and failed to find a single specimen! although in the years referred to they were so abundant as in '92 to spoil one-third of the gooseberries and black currants. The only reason I can give for the change, is that for the past few years, I have allowed the young chickens to run at large in the berry patch, and during fall, winter and early spring I allowed the large fowl to run at large also, and they may have exterminated the larvae after they had reached the ground. When I pick the crop if I find any wormy specimens I will forward them.

I remain yours truly,

A. W. THORNTON.

We addressed a letter to Prof. James Fletcher regarding its occurrence in Canada, and below is given his reply.

My Dear Prof. Harvey.

Your letter of July 23rd has been forwarded to me. The only place in Canada, from which I have received complaints of *Epochra Canadensis* is British Columbia, where I am told that in many places the black currants are rendered unusuable owing to the numbers of white maggots which came to the surface when these are cooked. This is presumably *E. Canadensis* although I have been unable to secure any specimens. I have received complaints concerning them for the last thirteen years. At one place, Cowichan on Vancouver Island, I was told in 1885 that black currants could not be used at all on this account.

I have been unable to find any specimens in gooseberries, although the large handsome fruit of *Ribes Lobbii* (a gooseberry) is certainly attacked by some larvae on Vancouver Island.

Regretting that I am unable to give you more information.

Believe me to be yours truly,

J. FLETCHER.

Mr. Wm. Cann of Topsam, Maine, writes us that his curants in 1895 were stung and a maggot was formed inside. No specimens were sent, but it was probably the above insect.

From the above data it is quite certain that *Epocha Canadensis*, Loew, is a native American species, distributed throughout the northern part of the United States, and in Canada, extending from the Atlantic to the Pacific coast. It will be interesting to determine whether it infests native currants and gooseberries and from them has transferred it depredation to the cultivated varieties.

Observations—How Does the Fly Oviposit.

She runs over the currant in a nervous restless manner keeping the wings in a constant fanning motion. Often examines carefully several currants before finding one to her fancy. Usually one of the large currants in the upper part of a bunch that is in the shade is selected. Then coming to rest the last three segments of the abdomen are turned at quite an angle forward under the abdomen. The hind feet are set bracing backward and outwards. Then the truncate end of the last segment rests on the currant and the ovipositor is protruded making a puncture. The probing continues very rapidly for fully five minutes at least, a plunge is made in every second. The last segment is occasionally raised during the process showing the protruded sheath of the ovipositor and the ovipositor inself. Finally the plunging motion changes to a vermicular movement of the abdomen to expell the egg which lasts about half a minute when the ovipositor is withdrawn, and the deed is done. The

mouth parts are constantly in motion during the process. But one egg is laid in a place.

Nature of the Reproductive System.

We dissected several females and found the ovaries double. The eggs giving the abdomen a swollen appearance and filling the abdominal cavity. The egg masses consisted of about ten chains of eggs on each side, each chain in about ten stages of development, making the possible number of eggs the flies are capable of laying fully 200.

The developmental stages are strikingly like those of *Trypeta pomonella*, figured in our 1889 Report, and as in that insect the egg laying period must extend over considerable time.

When Do the Flies Emerge.

Specimens kept in jars in a warm room began to emerge the last week in April, but in nature were first noticed about June first. They were mating at that date and punctures on the currants were abundant indicating an earlier emergence than June 1st. The time varies with the season and locality. No flies were seen in 1896 before June 5th.

How Long Do They Continue on the Wing.

Specimens were quite abundant about the first of June, were most abundant from June 9th to 15th, and by June 25th more were to be seen about the bushes. Making allowance for difference of time of emergence the period of flight would not be over a month at the longest.

What Is the Nature of the Puncture.

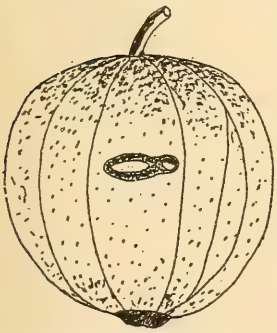


Fig. 7-a. Currant showing the relative position of the puncture and deposited egg.

It is scarcely visible at first but soon becomes surrounded by a brown areola and then is shown to be nearly circular and about a half mm. in diameter. Extending from it at one side is a narrow portion of the epidermis from which the sub-epidermal cells have been removed by the ovipositor, giving it a semi-transparent appearance through which the egg can be clearly seen close under the skin to one side of the puncture.

This portion of the epidermis covering the egg soon becomes whitish, opaque and sunken. We were at a loss at first to know how the egg could be deposited so close to the skin at one side of the puncture but a study of the pro-

truded ovipositor shows that it turns backward at right angles near the end, so that the egg is inserted at an acute angle backwards to the position of the last segment of the abdomen during the deposition. An examination of Plate I, Fig. 9, which shows the protruded ovipositor will make this plain. The end of the egg opposite the pedicel is the one inserted first as shown by the eggs in the oviducts and the position of the deposited egg to the puncture. It is from this end that the larva emerges. We have in this species another instance of deposition of the egg under the skin of the fruit by means of a sharp ovipositor, as in *Trypeta pomonella*, Walsh.

Egg Laying Period.

The eggs are laid one in a place occupying about five minutes for the deposition. The insects are capable of laying fully 200 eggs. The time they are on the wing is about three weeks. This would require that several be deposited each day. An examination of the ovaries showed that about two eggs of each chain or about twenty were practically perfectly developed. The short life period would require rapid maturation of the eggs. If ten were laid each day three weeks would be required to complete ovulation. They may be deposited even faster than this.

The Flies Single Brooded.

Specimens of the pupae taken from the ground under the bushes, about the time the currants were mature, remained in the ground in a warm room all winter but did not emerge until April. Those in nature emerged about June 1st. The insect therefore spends about eleven months of the year in the ground.

How Long Does It Take the Larvae to Mature.

The larvae began to emerge June 20th. An examination of many currants at that date showed that quite a per cent contained full grown larvae. The deposition of eggs began about June first which would indicate three weeks as the time required for full growth. As we found at this date larvae from two mm. to seven mm. in length it would extend the time that the fruit is infested from the laying of the first eggs to the maturity of those last laid which would be fully six weeks. Our observations indicate that the larvae do not leave the fruit as soon as matured which would extend the time still farther. We had some larva pupate as late as July 15th.

Nature of the Work of the Larvae.

When hatched the larva is about one mm. long and as soon as it emerges from the egg begins to travel, often leaving a delicate light colored trail close under the skin which can be seen through it. This is not always the case. After traversing from a third to a half the distance around the currant it locates, entering in most cases one of

the seeds, disappearing entirely within it. Sometimes the larva locates near the puncture and sometimes the exit hole is on the opposite cheek from the puncture. As it grows the head finally protrudes from the seed as shown in Plate I, Fig. 7. After feeding upon the contents of a seed and having grown too large to find lodgment within it, it locates between the seeds in the pulp and then gnaws holes in the seeds eating the contents of one after another until often the contents of at least half a dozen are consumed before the larva is grown. They seem to reject the coats and the clear gelatinous envelope that surrounds the seeds. The refuse of the seeds eaten turns black and becomes cemented together. A black spot becomes visible through the skin. The location of the larvae can be told readily as the currants infested soon begin to show a clouded appearance where they are located. That cheek turns red earlier and rapidly a deeper red and finally a black spot. Infested fruits ripen earlier. Often half grown larvae will be found with the head end half buried in a seed. Finally when full fed the larvae gnaw to the surface and cut a circular hole about 1.5 mm.d. through the epidermis by means of which they emerge with ragged edges.

Do the Currants Drop While the Maggots are Still in Them.

On June 22nd we collected several hundred currants that had fallen on the ground. One hundred of them were carefully dissected and every one contained a maggot excepting two from which the maggots had emerged leaving the evidence of their work. (We put about two hundred of the currants in a box and on June 24 twelve pupae were found.) The maggots were of various sizes from 2.5 mm. to 7 mm. showing that the currants often drop before the maggots are mature. On the same date we took quite a number of currants from the bushes that were turning red. They were the large ones at the base of the bunches and invariably were infested by a maggot. The maggots were of various ages, some full grown, but would not average as large as those found in the currants on the ground.

Do the Larvae Leave the Fruit as Soon as It Falls.

An examination of currants picked from the ground under the bushes contained larvae of various ages, 7 mm. 4 mm. 3 mm. and 2 mm. in length.

Put quite a number of infested currants in a box June 22nd and some of them did not emerge and pupate before July 15th. The most however emerged in five days.

Quite a number of currants were found on the bushes containing evidence of aborted work showing some mishap to the egg or developing larvae. There were others which showed an exit hole proving that quite a number of the maggots drop to the ground from the currants before they fall. Quite a number of currants showed more than one egg puncture and several from two to three live and flourishing larvae.

Are All of the Fruits in the Bunches Affected.

The inflorescence of the currant is racemose and the fruits at the base develop first and are first in condition to receive eggs. In these the earliest laid eggs are placed. The currants at the ends of the bunches were exempt and ripened good fruit after the flies were done ovipositing.

Where Does the Insect Spend the Winter.

When the larvae are ready to transform they crawl out of the currants and enter the ground a short distance if it is suitable, or they may transform on the surface under rubbish. They may be found in abundance in the ground under the bushes in the fall. The larval skin is not cast but the larva shortens up becoming a coarctate pupa of a pale yellowish brown color. In this condition the insect spends eleven months of the year gradually undergoing changes into the fly which emerges the following season.

General Description.

Perfect insect a two-winged fly about the size of a house fly. Pale yellow or orange with greenish iridescent eyes and dark bands across the wings. Found about currant and gooseberry bushes during June in Maine. Stings the currants, depositing an egg under the skin, that hatches and develops into a small white maggot causing the fruit to turn red and drop prematurely. The maggots when grown leave the fallen or hanging fruit, enter the ground, change to the pupa state from which the fly emerges the following June.

Technical Description.

Female Fly—Pale clay-yellowish or in darker specimens pale orange. On the border of the front on each side, are three or four long, but rather weak black bristles which curve toward each other. Between the ocelli and the last bristle on the border of the front is a single bristle that curves toward the vertex. On the vertex near the eye two bristles the inner much longer. Antemae darker yellow than the head, third joint rounded at the tip; arista blackish, yellow towards the base, with a very short pubescence. Rostrum and palpi pale yellow, the latter not reaching beyond the anterior edge of the oral opening. Thoracic dorsum with a very thin, whitish bloom, a double middle stripe and a narrow lateral stripe, rather shining and somewhat darker than their surroundings. The posterior end of the thoracic dorsum and the scutellum, shining, very pale yellow; a not very broad yellowish stripe runs from the humeral corner to the root of the wings. The scutellum convex and not very large; bristles on the scutellum four. The bristles of the thorax and of the scutellum,

as well as the short pile of the thoracic dorsum, are black. Metathorax distinctly infuscated on its superior margin and its middle line. Abdomen shining, with short black pile; the fourth and fifth segments marked by a chestnut brown or black cross band interrupted in the middle, the third usually and sometimes the second segment with a lateral beginning of such a stripe indicated by a chestnut-brown or black spot. Pale specimens without abdominal markings excepting upon the long seventh which in all specimens is dark on the proximate dorsum and at the distal end. Seventh segment equal to the three preceding segments taken together, very broadly truncate and infuscated at the end.

The seventh segment contains the retractile sheath of the ovipositor and the ovipositor. The sheath is clyindrical,broadest at the ends. Clothed with retrorse scales arranged in six longitudinal bands at the base which are brownish toward the end and becoming black near the base. Toward the end the scales become smaller and cover the whole surface, and at the middle the six bands are merged into four.

The ovipositor provided with two guides which are flat, obtuse at the ends and extend three-fourths its length. The ovipositor brown, flat, serrate on the edges, each edge with three teeth. The basal tooth remote. Both faces of the distal lateral teeth each bear two rows of five black bristles. See Plate II. The tip pointed. The principle is that of a double edged serrated hay knife or a *Crysty Bread Knife.*

The front femora are sparsely beset with bristles upon the upper and under side; the middle femora are entirely without bristles; upon the hind femora, likewise, there are only a few bristle-like hairs before the end of the upper side; the upper side of the hind tibiae is merely beset with exceedingly short bristle-like hairs. Wings of the usual shape, hyaline, with a pale-brown picture or in darker specimens nearly black; it consists: 1. In an oblique half crossband running from the humeral crossvein to the basis of the second basal cell; 2. Of a crossband parallel to the first, abbreviated behind, which begins at the stigma, near the anterior margin, and runs across the basis of the submarginal cell, as well as across the cross veins, which close the second and third basal cells, and thus reaches the sixth longitudinal vein; 3. Of a rivulet which begins above the posterior crossvein, near the third longitudinal vein, runs from it across the posterior crossvein as far as the posterior margin, is continued along this margin inside of the third posterior cell, but, before reaching the sixth longitudinal vein, is suddenly turned upwards, running parallel to the band which begins at the stigma, crossing the small crossvein, and thus reaching the anterior margin, where, gradually expanding, it forms a border ending a little beyond the tip of the fourth crossvein. The two crossbands as well as the rivulet, are of moderate breadth only; the latter has, in the described specimen, the following faded spots, which, in more fully colored specimens, are probably less apparent or alto-

gether absent. 1. A rounded spot in the marginal cell, above the origin of the rivulet; 2. Upon the longitudinal axis of the submarginal cell an indentation in the inner margin of the section bordering the apex of the wing; 3. Upon the longitudinal axis of the first posterior cell an interruption of the rivulet at its origin and an indentation in the inner margin of the portion bordering the apex of the wing; 4. Upon the longitudinal axis of the discal cell a narrow interruption of the section, running again towards the anterior margin; 5. The spot upon the posterior margin connects the first, descending, portion, with the second, which rises again upwards. The first and third longitudinal veins are bristly; the third and fourth are parallel towards their end, both very gently curved backwards; the section of the fourth vein preceding the discal cell is gently, but rather distinctly arcuated backwards, so that the shape of the discal cell somewhat reminds of that of the species of Rivellia; the crossveins are comparatively rather long, moderately approximated, their distance being about equal to the length of the posterior crossvein; the latter is rather steep, however, perceptibly approximated to the apex with its anterior end, more than with the posterior; the posterior corner of the anal cell is very much drawn out in a point.

Male Fly—Pale clay yellow to pale orange. Smaller than the female and the color and wing picture the same but paler. The head and eyes as in the female. In front view about as long as broad with mouth up, anterior distance between the eyes only half as great as the posterior. The three ocelli brownish. Three long, weak black bristles upon the border of the front as in the female. On the occiput just above the neck are two clusters of six black hairs each, that lie parallel to each other. The antennae darker yellow than the head. The terminal joint twice as long as broad, rounded at the end and not reaching the mouth. Palpi and rostrum yellow the former not reaching beyond the mouth. Arista black, pubescent yellowish at the base.

The thoracic dorsum bears a faint double median stripe and also a narrow lateral stripe. The pollinosity in our specimens seems to be continuous over the whole surface and not absent from the stripes as described by Loew. The entire thoracie dorsum covered with short black hairs excepting the posterior portion. The scutellum is naked excepting that it bears *four long black bristles.* Post border of scutellum dark colored and together with a median dark stripe on the posterior metathorax makes a T shaped marking. Sides of thorax armed with five long black bristles. Four shorter weaker hairs on anterior of thorax. Halteres pale.

Femur of the anterior pair of legs armed with long black bristles. Femur of other legs unarmed. The two posterior legs darker. Abdomen oblong, arched, width to length as 5:8. Composed of six segments, ratio 3:4:4:4:5:2. The basal bears an obscure median dorsal brown spot. The posterior portion of the abdomen darker yellow.

Fourth and fifth segments each bear an obscure brown spot on the lateral dorsum. Part border of the narrow sixth segment dark brown but usually turned under the abdomen so that from above the end of the abdomen appears yellowish. There is a row of ten long bristles on the posterior border of the fifth segment (see Plate I, Fig. 10.) Attached to the lower surface of the sixth segment is the external genital apparatus composed of claspers, guide and penis. The claspers are club-shaped and notched near the posterior end on the interior edge. The guide between the claspers is a horse hoof shaped organ half as long as the claspers ending in a tuft of hairs and backward narrows into a small pedicil. The penis is exceedingly long, bearing at the end an enlargement to which is attached a pedicilate pear-shaped appendage. See Plate I, Figs. 8 and 10.

The wings as in the female.

Measurements of Male Fly.—Total about 6.5 mm. Head .931 mm. long, depth .1064 mm. exclusive of rostrum, breadth 1.729. Width of eye from dorsal view .399 mm. Front view nearly round, about .745 mm. with mouth up anterior distance between eyes .675 mm. posterior, 1.33 mm. Arista 2.93 mm. Thorax 2.13 mm. long. Abdomen 3.46 mm. long, 1.33 mm. wide. Segments in the ratio 3:4:4:4:5:2.

Eggs—Opalescent white, oblong, pedicelate. The pedicelate end more pointed than the other which is somewhat obtuse. The pedicel with a short narrow neck and bulbous at the end. The pedicelate end for about one-third of the length sculptured by raised lines arranged in a hexagonal pattern giving a rough pitted surface, most conspicuous near the pedicel and gradually lost in the smooth surface of the opposite end, about four and a half times as long as wide. They measured 1.064 mm. by .24 mm. in one specimen and 1.04 mm. by .25 mm. in another. (Plate I, Fig. 2.)

Larva—Length 7 mm. (.28 in.); breadth 1.5 mm. (.06 in.) White with sometimes a faint rosy tint, probably due to absorption of the colored juice of the currant. Footless body composed of about thirteen segments. Widest in the middle, tapering rapidly toward the head, which is small, pointed and emarginate. (Plate I, Fig. 3.) The mouth circular surrounded by a zone of ridges and furrows. From the mouth protrudes two curved parallel retractile black hooks, the *rasping organs* of the larva, by means of which it gnaws the fruit. (Plate I, Fig. 6.) The chitinous frame work to which these hooks are attached shows as a black area in the second and third segments. These hooks and frame work give the end of the head a black appearance. There are two pairs of tubercles upon the front of the first segment. The lower pair smaller. (Plate I, Fig. 6.) The cephalic and candal spiracles are yellow. The former between the third and fourth segments and lacerate funnel formed. The latter are on the posterior face of the last segment and end in three finger like thorns. (Plate I, Fig. 5.) These are connected by trachea with large anastomosing branches at the posterior and anterior ends. The larva when first hatched is about 1 mm. long, and slender

This larva looks much like that of *Trypeta pomonella* and could not be separated without a hand glass, but the mouth, head and candal spiracles are quite distinct.

Pupæ—Five mm. long by nearly 2.5 mm wide, broadly oblong, straw colored, coarctate. The head end more pointed and showing the cephalic spiracles. The candal spiracles also apparent. In emerging the fly breaks away the lower half of the first four cephalic segments. The pupa is shown in Plate I, Fig. 4.

Critical Remarks.

Mr. Loew says in the introduction to Part III of his "North American Diptera" (Smithsonian Miss. Colls. p. 213) I have been compelled to draw the descriptions of several species from single, often badly preserved specimens, and I am afraid that these descriptions * * * may sometimes betray the incompleteness of my material." Appreciating this fact the critical remarks made below are not given in the spirit of a criticism but to supplement what has been written after the careful examination of an abundance of material. Loew must have examined faded or pale colored specimens as the larger and better developed individuals have the abdominal markings dull black and also the markings on the wings are much too dark to be described as having "a pale brown picture." There are occasionally females with slender abdomens which are without markings. These seem to be *unimpregnated* or possibly through ovipositing. The intensity of the color in others is variable. There is a dark uninterrupted band across the posterior border of the sixth segment. Loew calls the last abdominal segment of the female the ovipositor, a mistake which entomologists made in regard to *Trypeta pomonella*, Walsh. The last abdominal segment is about as long as the three preceding, conical, truncate at the end, and retracted within it are sheath and ovipositor. Mr. Loew evidently did not see the ovipositor which we have described and figured. (See Plate II.) He also makes a mistake regarding the number of abdominal segments, there being *seven* the one at the base having been overlooked. Therefore, the description given by Loew, "the third and fourth segments have, each at its basis, a chestnut cross band interrupted upon its middle, while upon the second segment only a lateral beginning of such a stripe is indicated by a chestnut brown spot," would have to be corrected by saying fourth and fifth and third segments respectively. Mr. Loew is in doubt regarding the number of bristles upon the scutellum, which we find is four upon *both* male and female. In the brighter colored flies there is a decided orange tint, which would require a modification of the statement that the color is "pale clay yellowish." We find that the number of bristles on the border of the front is usually three on each side; but it varies from two to four. In some specimens three on one side and four on the other. Mr. Emerton's drawing (Plate I, Fig. 1) shows four.

Saunders says it "lays its eggs on the currants while they are small." Our observations are that the eggs are inserted under the skin through a small hole made by the sharp ovipositor, and that the currants are quite large before the eggs are laid, and that the largest ones at the base of the bunches are usually selected first. He also makes a mistake when he states that the larvae leave "a round, black scar at the point of entry." The young larvae usually travel some distance from where the egg is deposited before establishing headquarters. The black scar locates the larva, and results from the decomposition of the parts injured and the exuviae of the larvae. The *exit* hole of the larva is usually located in the black scar. The puncture made to lay the egg is too small to be noticed excepting by close examination. He also says the insect "probably passes the chrysalis state in the ground, a guess which is confirmed by finding the pupae in abundance in the ground under the bushes.

Prof. Snow correctly doubts that the abdomen of the male is "short and rather broad," but the black of the abdomen in well colored specimens is natural. The abdomen of the female varies from very narrow in unimpregnated specimens or those through depositing to every broad in those full of eggs. The abdomen of both shrivel and change form in drying, and the colors are duller. The abdomen of the male has but six segments, and from that reason is shorter than that of the female though the segments preceding the sixth are larger than those of the female.

We are at a loss to know how Prof. Snow can arbitrarily "consider six as the number of segments composing the abdomen of the female trypetid and five as composing that of the male," when nature has decided the matter by giving the former seven and the latter six. Certainly it can lead to nothing but confusion as has Loew's discrepancy in the correct number. We can't even see any good reason for longer perpetuating the error that the long terminal abdominal segment is the ovipositor, for it certainly has nothing to do with ovipositing. It is not inserted at all into the puncture and merely has the ovipositing apparatus attached to it and when not in use telescoped within it. The fine plate which we give of the ovipositor from the pen of Mr. Emerton should settle this matter.

There are also six well defined segments separated by sutures in the male abdomen in front of the external male genitalia as shown in Plate I, Fig. 10. The terminal segment is, however, short.

Prof. Gillette's observations of the habits of this insect agree with ours very nearly, though he studied its work upon gooseberries instead of currants. We are, however, of the opinion that the currants stung remain on the bushes much longer than he records for gooseberries, and that the red spot develops where the larvae is located instead of where the egg is deposited. In currants the egg is not laid in the pulp, but at one side of the puncture close under the skin, so it can readily be seen through it.

The figure of the fly given shows but four abdominal segment, anterior to the long terminal one while there are really six. The thorax dorsum is not of uniform color as shown, but is faintly double striped down the middle and at the sides by the absence of the whitish bloom that covers the upper surface. See Plate Fig. 1. The thorax is too long and the head too narrow and small.

We find that quite a number of the maggots leave the currants before they drop. This may not be so with gooseberries. For currants we can not recommend gathering the fallen fruit as only a partial remedy.

Remedies.

We have had no experience with this insect as it is new to Maine as an injurious species. From a study of its life history we discover only one vulnerable point. The insect spends eleven months of the year in the ground and can not be reached. In the winged stage it cannot be destroyed so far as we know. The eggs are deposited under the skin of the fruit and spraying would do no good. *Part of the infested fruits drop prematurely and the worms remain in them for some time before they emerge and go into the ground.*

(a) Based upon this last habit we would recommend gathering up the fallen currants frequently and burning them.

This remedy cannot be relied upon to destroy *all* the flies as quite a number of maggots leave the fruit before they fall. It can be depended upon to destroy fully half if not more and can be employed to keep them in check.

(b) As these flies are weak and liable to perish if any obstruction is offered to prevent their coming out of the ground, we would recommend a mulching of coarse straw or hay, several inches deep, placed under the bushes and out as far as the branches extend, and well packed.

(c) As the larvae find fine dry dusty substances prejudical to their transformation a heavy dressing of coal ashes placed under the bushes in June would destroy many of the larvae and also prevent the flies from emerging the following spring. Prof. Jordan tried this on his garden without flattering results.

(d) Our western correspondent Dr. W. A. Thornton thinks that allowing young chickens about the bushes early in the season and large fowls later after the fruit is gathered will keep them in check.

(e) A radical remedy would be to pick and destroy the crop after the eggs are largely laid and before the currants drop, or pick the entire crop while green and before the flies appear. If there are no currants of course no eggs could be laid, and the flies would have to go elsewhere or perish.

(f) As the pupae are found only about an inch below the surface, they could be destroyed with little trouble by removing the soil to that depth from under the bushes and burying it deep or depositing it on a road or some exposed place.

(g) We have not discovered any parasites to help check the pest. Short bearing years would tend to reduce the numbers.

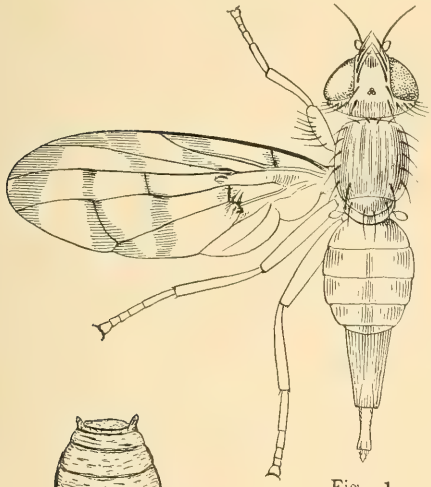


Fig. 1.

Fig. 2.

Fig. 4.

Fig. 5.

Fig. 3.

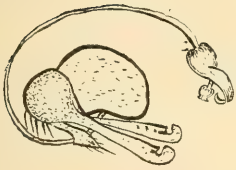


Fig. 8.

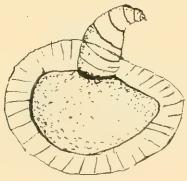


Fig. 7.

Fig. 6.

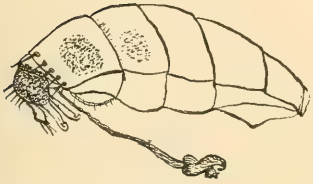


Fig. 10.

Fig. 9.

The Currant Fly, Gooseberry Fruit-Fly.
(*Epochra Canadensis, Loew.*)

EXPLANATION OF PLATE I—THE CURRANT FLY.

(*Epochra Canadensis,* Loew.)

All excepting Figure I were drawn by the writer.

Figure 1. The female fly enlarged about seven and a half times. Drawn by Mr. J. H. Emerton from slides of the wing and ovipositor prepared by the writer and from pinned flies. The two basal joints of the abdomen are drawn as one. The real number, including the long terminal segment is seven instead of six.

Figure 2. Egg showing form, sculpture and pedicel, enlarged fifty times.

Figure 3. The larva enlarged about five times.

Figure 4. The pupa enlarged eight times.

Figure 5. The candal spiracle of the larva much enlarged.

Figure 6. First two segment of the head showing the tubercles on the head, the rugose mouth and the rasping organs. Enlarged twenty-five times.

Figure 7. Seed of currant with gelatinous envelope showing larva protruding from it. Enlarged.

Figure 8. External genitalia of male. Enlarged twenty times.

Figure 9. Side view of abdomen of female with ovipositor protruding and bent backward in the position it takes as the egg is deposited under the skin to one side of the puncture. Enlarged.

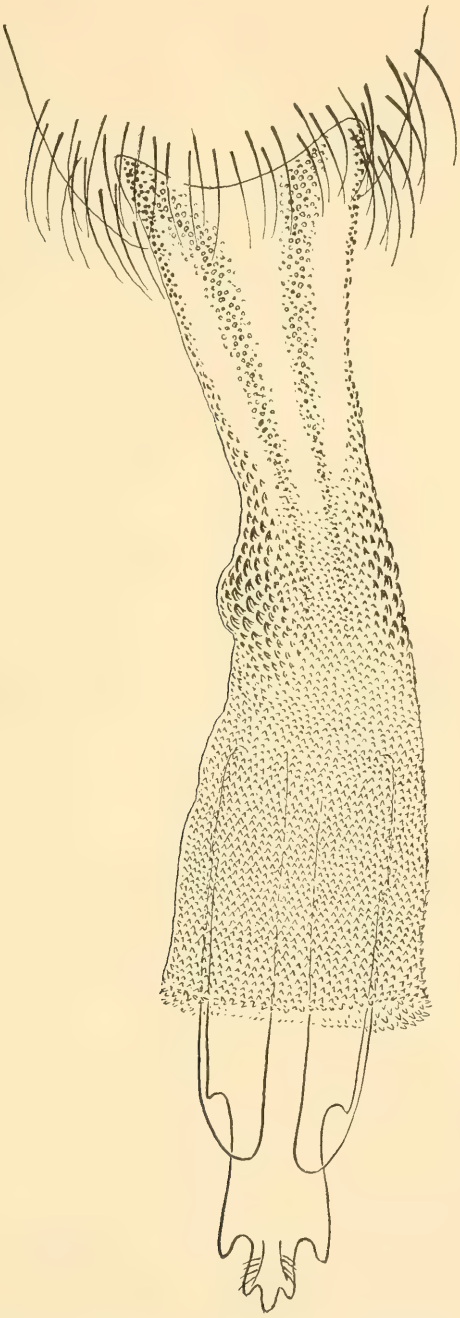
Figure10. Abdomen of male with gentalia and showing six segments. Enlarged.

EXPLANATION OF PLATE II—THE CURRANT FLY.

(*Epochra Canadensis*, Loew.)

This plate prepared by Mr. J. H. Emerton from dissections made by the writer, shows the end of the last abdominal segment; the sheath of the ovipositor; the guide; the ovipositor; the bristles terminating the abdomen; the triangular scales that point backwards and cover the most of the sheath; the teeth upon the ovipositor and the small bristles near the end.

When not in use the ovipositor and guides are telescoped into the sheath and the sheath into the long terminal abdominal segment. The figure is enlarged one hundred and twenty times.



The Currant Fly, Gooseberry Fruit-Fly.
(*Epochra Canadensis, Loew.*)

APPENDIX.

Bulletins Issued in 1895.

BULLETIN No. 17.

IMPORTANT FACTS ABOUT CORN.

Bulletin No. 11 of this Station treats of the relative yield of mature Maine Field Corn and immature Southern Corn.

The data collected during a study of this matter show certain allied facts that are of much importance to the farmer who is planning to produce corn the coming season as a fodder or silage crop.

Composition of Mature Maine Field Corn and Immature Southern Corn.

Analyses of the experimental crops of corn on the College farm reveal the composition displayed below.

Crops of 1892 and 1893, average.	In 100 Pounds Green Corn.						
	Water —lbs.	Dry substance —lbs.	Ash—lbs.	Protein Nx6.25 —lbs.	Fiber—lbs.	Nitrogen free extract—lbs.	Fat—lbs.
Southern corn, immature	84.80	15.20	1.18	1.78	4.20	7.70	.34
Maine field corn, mature.....	78.91	21.09	1.28	2.28	4.15	12.77	.61
Excess in field corn.....	-	5.89	.10	.50	—.05	5.07	.27

It appears from these averages that under the conditions existing in Maine, which require the cutting of the large varieties of corn in an immature state, the Maine field corn which reaches maturity, contains the larger percentage of dry matter. Again,

the excess of dry matter in the Maine field corn consists almost wholly of the non-nitrogenous compounds classed under the head of nitrogen-free-extract.

The Maine Field Corn is in this case worth forty per cent. more than the immature Southern Corn, pound for pound, judging simply by the per cent. of dry matter. The great bulk of the Southern Corn fodder is not a proof of greater or even of equal value.

The Effects of Maturity upon the Maine Field Corn in Composition and Yield.

Composition: In order to obtain testimony on this point, in 1893 a field of Maine corn was cut in five different lots, ranging in times of cutting from August 15th to September 21st, and in stage of growth from the early formation of the ear to full maturity. The analyses of samples from these different cuttings appear below.

	In 100 Pounds Green Corn.						
	Water—lbs.	Dry substance—lbs.	Ash—lbs.	Protein Nx6.25—lbs.	Fiber—lbs.	Nitrogen free extract—lbs.	Fat—lbs.
Maine field corn, cut Aug 15	88.29	11.71	1.09	1.75	3.10	5.46	.30
Aug. 28.....	82.50	17.50	1.14	2.05	4.08	9.71	.52
Sept. 4.....	80.45	19.55	1.21	2.22	3.85	11.68	.59
Sept. 12.....	76.83	23.17	1.29	2.22	4.48	14.50	.68
Sept. 21.....	74.66	25.34	1.50	2.34	4.71	16.04	.75

The immature and mature corn differ in the following essential particular:

The mature corn is less watery; i. e., it contains a much larger percentage of dry substance. During the thirty days before the mature crop was harvested there was a continuous and large increase in the percentage of dry matter. It will appear later that this was mostly due to an actual growth of dry matter, rather than to a drying out of water.

Yield: The field of corn selected for studying the influence of maturity upon the yield was of very uniform growth, being finely eared and in every way satisfactory for experimental purposes.

Each of the ten plots consisted of five rows, and it was decided to harvest one-fifth of the crop or one-tenth of an acre at each of five periods of growth, cutting one row of each plot at each period.

Date of cutting and condition of crop.	Days in each period of growth.	Yield per Acre.		Gain in weight in each period, dry matter—lbs.	Rate of gain per day, dry matter—lbs.
		Green corn.	Dry substance.		
August 15, ears beginning to form	....	26,166	3,064.0	.....	.....
August 28, a few roasting ears	13	29,777	5,210.9	2,146.9	165.0
September 4, all roasting ears	7	31,000	6,060.5	849.6	121.3
September 12, some ears glazing	8	28,833	6,680.6	620.1	77.5
September 21, all ears glazed	9	27,777	7,039.7	358.1	39.8
Increase dry matter after August 15	.....	.....	.....	3,974.7	.....

The results of this experiment certainly furnish a striking illustration of the folly of harvesting immature corn for silage or fodder purposes whenever it is possible to allow it to attain maturity.

In this instance, *the total quantity of dry matter in an acre of the corn at maturity was nearly two and one-half times greater than at the silking period thirty-seven days previous*, the average rate of increase of dry substance per acre being about 108 pounds daily. This daily increase is equivalent in quantity to one day's ration for four or five cows of ordinary weight.

The Influence of Maturity upon the Quality of the Dry Matter in the Corn Plant.

It is well known that the portion of the plant known as nitrogen-free extract is a mixture of substances such as sugar, starch, gums, waxes, etc., some of which have a higher value than others for use by the animal. In short, the larger the proportion of starch and sugars in the nitrogen-free-extract of a food, the more highly do we estimate the nutritive worth of that food. For this reason a higher value is placed upon the nitrogen-free-extract of the grains than upon that of the coarse fodders.

It is evident then, that if allowing the corn plant to mature increases the relative proportion of sugars and starch in dry matter, we have not only the advantage of obtaining a larger yield of dry matter but we secure material of better quality for food purposes. The figures show the facts as obtained from a single investigation.

	Proportion of starch and sugars in Nitrogen-free extract.	Pounds of starch and sugars yielded per acre.
	%	lbs.
August 15, ears beginning to form	*25.1	*358.5
August 28, a few roasting ears	40.5	1,172.0
September 4, all roasting stage	42.7	1,545.0
September 12, some ears glazing	42.2	1,764.0
September 21, all ears glazed	50.3	2,244.0

* Probably somewhat too low.

It appears from the figures that not only is there a constant and large growth of starch and sugars up to the condition of maturity of the corn plant, *but these valuable compounds increase more rapidly than certain less important constituents, so that the mature plant substance is of better quality than at any previous stage of growth.*

Summary.

(1.) Under the conditions existing in Maine the varieties of Flint Corn which mature in the state furnish fodder or silage material much more valuable, pound for pound of fresh weight, than it is possible to secure with the larger varieties of Dent Corn which do not mature.

(2.) The Flint varieties of corn should always be allowed to mature, as there is a large and continuous production of plant substance up to the period of full maturity. Harvesting half grown or immature corn is a wasteful practice.

(3.) Owing to the relatively large production of sugars and starch in the late stages of growth, a pound of the dry substance of the mature well-eared corn plant possesses a higher nutritive value than at any earlier stage of growth.

W. H. JORDAN.

Maine State College,
Orono, Me., March 1, 1895.

BULLETIN No. 18.**

INSPECTION OF FERTILIZERS, 1895.

W. H. JORDAN, Director.

J. M. BARTLETT, L. H. MERRILL, Chemists.

The Maine Legislature enacted at the session of 1893, a new law for the regulation of the sale and analysis of commercial fertilizers.

This change of law was sought in order to accomplish two objects:

1. The providing of funds that can be legally used, sufficient to pay the expenses of a proper inspection.

2. A provision whereby information as to the composition of the goods offered for sale can be given to the would-be purchaser at an earlier date than has heretofore been possible.

This law makes the following requirements upon manufacturers, importers or dealers who propose to sell or offer for sale their goods in the State. These briefly stated are:

1. Marking the bags properly.*

2. Filing annually a certificate with the director of the Station giving the manufacturer's or dealer's name, place of business, place of manufacture, name of brand of fertilizer and the guaranteed composition of the same.*

3. Depositing annually, unless excused by the director under certain conditions, a sample of fertilizer, with an accompanying affidavit that this sample "corresponds within reasonable limits to the fertilizer which it represents." These samples are designated in this bulletin as "manufacturer's samples."*

4. The annual payment of an analysis fee of fifteen dollars for every brand of complete fertilizer licensed.

5. All brands of which thirty tons or more are not sold are exempt from the last provision.

The law also imposes upon the Director of the Maine Agricultural Experiment Station certain duties which are:

1. The issuing of licenses to such manufacturers as comply with the above named requirements.

2. The analysis of the samples deposited by the manufacturers.

3. The selection of samples in the open market of all brands of fertilizers sold or offered for sale in the state, with the subsequent analysis of the samples.

4. The publication of bulletins or reports, giving the results of the inspection.

In accordance with the foregoing requirements, eighteen companies representing seventy-two brands of fertilizers have complied with

** Given in part.

* Notice.—That requirements 1, 2 and 3 apply to all brands of fertilizers, whether thirty tons are sold or not.

the law, and the brands mentioned below can be sold legally in the state to the extent of thirty tons or more during the year 1895.

(The bulletin gave the manufacturer's guarantees and the analysis of manufacturer's samples, but as these figures are of only passing value they are omitted here. W. H. J.)

BULLETIN No. 19.

A DISCUSSION OF CERTAIN COMMERCIAL ARTICLES.

(1) Fertilizers.

A large sum of money is annually expended by Maine farmers for commercial fertilizers and commercial cattle foods. The trade in these articles offers, therefore, wide opportunities for the practice of fraud, and for the sale of various nostrums and mixtures at prices several times larger than the value to the purchaser of the goods delivered. Through credulity, lack of accurate knowledge and hasty judgments Maine farmers have suffered their fair share financially at the hands of plausible "agents." In too many instances the goods are first bought for cash or on credit, invariably at an unusually large price, and then after the act is past recalling, information is sought as to the character and value of the "fertilizer" or "food" purchased. If accurate information were first obtained in these cases there would be less of these transactions where value is not received for the money paid.

There are two claims which generally characterize the representations of the companies and agents selling these questionable goods:

(1) The process of manufacture is a secret one, having been "discovered" by some one who is generally unknown either to science or practice.

(2) The "fertilizer" or "food" either contains ingredients of which the whole world, outside of a favored few, is ignorant, or else certain ingredients are so wonderfully compounded as to produce marvelous results.

In all instances that have come under the writer's notice such materials have ingredients of some actual value for feeding plants and animals. Are the claims of extraordinary value well founded?

Let us examine some of the cases that have been investigated.

Fertilizers.

There is a case in hand just now which well illustrates the sale (attempted at least) of a fertilizer in accordance with claims that cannot be justified by existing knowledge, and at a price greatly out of proportion to the real value of the article.

Reference is made to the fertilizers offered for sale by The Chemical Compound Fertilizer Co., otherwise Mason, Chapin & Co., Providence, R. I.

From the published reports of this company and from the testimony of correspondents, concerning the price asked and the claims made by their agents, etc., we learn:

1st. The compounding of the fertilizers is a secret process. "The exact method in which this is accomplished is a secret of great value to us and which we do not propose to give away to the public."

2nd. The phosphoric acid is classed as "soluble in the soil," which to the chemist is an indefinite and suspicious form of statement.

3rd. No statements are made as to whether the fertilizers contain potash or not. They are advertised as containing certain percentages of "alkali," which may be interpreted as either potash or soda.

4th. Written testimony shows that the agent offering these fertilizers claims that 600 pounds of the form for potatoes would be found equal to a ton of the ordinary superphosphates.

5th. The fertilizers have been offered at the remarkable price of $55 per ton.

Fortunately for the farmers such new materials as the above are, in these days, very soon brought to the test of a severe investigation. Samples of these particular fertilizers have been examined at the Connecticut and Maine Experiment Stations, and the results of the analyses make these peculiar claims appear rather grotesque, and the price highly exorbitant. The following are the analyses:

	Connecticut Analyses.			Maine Analyses.	
	For potatoes—per cent.	For potatoes—%.	For corn—per cent.	For onions—per cent.	For potatoes—per cent.
Nitrogen in nitrates	4.03	3.56	1.47	3.43	3.42
Phosphoric acid soluble in water	.11	.22	.29	.....	.....
Phosphoric acid "reverted"	2.20	2.38	2.08	1.93	2.11
Phosphoric acid insoluble	11.51	10.08	13.70	13.00	9.48
Phosphoric acid total	13.82	12.68	16.07	14.93	11.59
Potash	.....	.....	.....	.14	.26
Valuation	$18 84	$17 23	$12 38	$17 73	$17 14
Selling price	50 00	50 00	50 00	.....	55 00

An examination at the Connecticut Experiment Station still more exhaustive makes it evident that the fertilizers are made up by mixing nitrate of soda, some crude, ground phosphate and probably soda ash.

The comments by the Connecticut Experiment Station on these goods and on the lately much discussed value of soda as a substitute for potash, are so entirely clear and sound that they are reproduced here.

"A mixture of 500 pounds of nitrate of soda, costing $12.50, 1200 pounds of basic slag costing $11.40 and 300 pounds of dry carbonate of soda, costing $6.00, total cost $29.90, would contain approximately the same quantities of nitrogen, phosphoric acid and soda and would have at least as great a crop-producing power as these fertilizers costing $50.00 per ton ($55.00 in Maine.)

The only valuable fertilizing ingredients contained in these fertilizers, viz:, phosphoric acid could, however, be bought for not far from $20.00, so that the plant food in these goods costs more than twice as much as the farmer needs to pay for it.

It is claimed that the soda existing in these fertilizers as carbonate and nitrate is an efficient substitute for potash in the plant and in the soil. So far as the plant is concerned a large amount of the most refined investigation would appear to demonstrate conclusively that soda cannot in any sense or to any extent take the place of potash in plant-nutrition. Plants growing in presence of abundance of potash usually take up and contain more potash than they really need. This accidental or unnecessary potash may indeed be replaced by soda, but both may be withheld without detriment to the plant. Even the salt-worts and seaweed which usually grow in soils or water containing much sodium compounds, flourish equally as well in absence of soda,but cannot exist in default of potash.

On the other hand, soda may sometimes or often take the place of potash as a fertilizer. In such cases it operates indirectly, not by entering itself into the crop as a needful food to the plants, but by its action on the soil, making more rapidly available some other ingredient of the soil, it may be potash, or lime or nitrogen, which is there present, but exists in a comparatively inert state. It is well established that the use of soda as a fertilizer has often increased crops, but experience shows that it is commonly an uncertain and unsafe application to land. In any case it does not enrich the soil or increase its stores of plant food, but simply facilitates their solution, consumption, and it may easily be, their waste.

As a rule soils contain more soda than potash and the frequent use of soda in fertilizers tends to exhaust and impoverish the land. If soda is to be used it is most cheaply supplied in nitrate of soda, which by its nitrogen may easily return its entire cost, leaving its soda in the soil as carbonate, and if more alkali is useful, lime is vastly cheaper than soda and not a whit less efficacious, is in fact, what soda is not, an essential element of plant-nutrition, as well as the safest and surest means of fluxing the

inert plant-food of the soil and putting its hoarded capital into active circulation."

Bulletin 20 will continue this discussion in the consideration of a certain class of cattle foods.

W. H. JORDAN.

MAINE STATE COLLEGE,
ORONO, ME., MARCH 15th, 1895.

BULLETIN No. 20.

A DISCUSSION OF CERTAIN COMMERCIAL ARTICLES.

(2) FOODS.

A class of materials commonly spoken of as "Condimental" or "patent" foods, has been found in our markets for many years. Now and then a new one appears, as has lately been the case in Maine. These foods are generally given some pretentious name such as "Condimental Cattle Food," "Imperial Egg Food," "Nutriotone," etc. They usually possess an aromatic or other positive odor, which to the uninitiated gives the appearance of value.

The claims that are made for the nutrient and tonic properties of these commodities are fairly startling as lying outside the range of either common experience or scientific knowledge, and on the strength of such claims these wonderful mixtures are sold in most cases at prices ranging from $100 to $2,000 per ton. How utterly absurd both the claims and the prices appear in the light of facts! Repeated careful examinations of these materials show that *without exception they consist principally of common cattle foods, or other common materials, mixed with small percentages of the cheapest and most ordinary medicinal substances.*

The following are the results of a number of examinations made by various experiment stations:

From Rep. Conn. Expt. Sta., 1878, p. 125.

"Condimental Cattle Food," cost $8.00 per 100 pounds. "It consists chiefly of corn meal and bran. It contains enough fenugreek to give it a strong flavor of that aromatic seed and likewise some seeds like caraway in appearance . . . ."

From Rep. Maine Exp. Sta., 1885, p. 52.

"Imperial Egg Food." Cost 50 cents per pound. Chiefly clam and oyster shells with some bone, also some pepper.

Johnson's Continental Food. Cost 75 cents for 10 pounds. "A mechanical examination shows that the food is undoubtedly wheat bran with possibly some middlings." Contains "some fenugreek" and "a little sulphur."

"English Patent Food." Cost $1.00 for a bag of 12 pounds. "Appears to be made up of middlings and corn meal, largely middlings. . . ." Contains "some fenugreek."

From Bulletin No. 20. Mass. Expt. Sta., p. 6.

"The Concentrated Feed." Cost $8.00 per 100 pounds. ". . . A mixture of several ingredients, among them was noticeable common salt."

From Rep. Conn. Expt. Sta. 1888, p. 146.

"The Concentrated Feed for Horses, Cattle, Sheep, Swine, Poultry, etc." "Apparently consists of a mixture of wheat and corn with thirteen per cent. of salt and perhaps a little of some more concentrated food." "Costs $100 per ton in three ton lots, ... $160 per ton in small quantities."

"The Concentrated Egg Producer." Cost $4.00 for 12 pounds, equivalent to $660 per ton. Contains both corn and wheat and some more concentrated food."

From Bulletin 15, N. H. Expt. Sta.

"Pratt's Food." Cost 75 cents for 12 pounds or $6.00 per 100 pounds. The food appears to be wheat middlings to which has been added some fenugreek and common salt."

"Weston's Condition Powder." Cost 50 cents for package of three pounds. "It resembled a mixture of corn meal and cotton seed meal and it had a saline taste and strong odor of fenugreek."

"Climax Food." Cost $1.00 per 12 pounds or $8.00 per 100 pounds. "It resembled a mixture of fine wheat middlings and wheat screenings together with a small quantity of caraway or fenugreek seeds and small bits of a substance like butter-nut or elm bark," also common salt 9.77 per cent., Glauber's salt, 4.50 per cent., and Chili Saltpeter 3.84 per cent.

From Rep. Maine Exp. Sta., 1892, p. 26.

"Pratt's Food." Cost $120 per ton. "Has the appearance of being chiefly ground bran or shorts. Contains a small amount fenugreek." . . . . "Contains something less than three per cent. of common salt."

From Rep. Conn. Expt. Sta. 1893, p. 244.

"Nutriotone." "It contains a considerable quantity of some leguminous seed, some linseed meal and perhaps other feeding stuffs together with aromatic substances (fenugreek, anise seed, caraway and the like,) and over ten per cent. of salt."

"Silver Live Stock Powder." Cost $1.00 per pound. "Consists essentially of ground bone having a dark color and slight odor of coal tar."

From Crop Bulletin No. 6, 1894, Me. Board of Agr.

"Nutriotone." Cost 25 cents per pound. (Sold in some cases for $7.00 for 50 pounds.) "Consisted largely of linseed meal with a litle fenugreek and apparently some pea or bean meal. It contained 18.67 per cent. ash, a large part of which was common salt."

The following are some of the statements that have been made by men who are students of animal nutrition, in regard to condimental cattle foods in general.

"Mr. Lawes of Rothamstead, England, made a most thorough, practical trial on the use of condiments in feeding, and demonstrated that there is no profit in it."—*Rep. Conn. Expt. Sta.. 1878, p. 125.*

"The foods have no greater nutritive value than wheat bran, middlings and corn meal from which they are made, while the small quantities of fenugreek and sulphur are utterly valueless to a well animal, and a poor reliance as a means of curing a sick one."—*Rep. Maine Expt. Sta., 1885, p. 53.*

"The practice of buying *compound* feeding stuffs in the general market, without a sufficient *actual* knowledge regarding the kind or the character of its various ingredients, ought to be decidedly discouraged; for the farmer who pursues that course, leaves his best interest to mere chance."—*Mass. Expt. Sta., Bul. 20, p. 7.*

"It has been abundantly proven that condimental foods have no advantage over others by reason of the condiments in them. As medicines they may well be distrusted in view of the absurd claims made by the seller."—*Rep. Conn. Expt. Sta., 1888, p. 148.*

"Quack horse doctors and Concentrated Cattle food manufacturers are twins, and they flourish, not on the ignorance of farmers, but on that lingering remnant of old times, which made saltpeter and sulphur the universal cure-all for horses and cattle. ..... The foods reported below are worth only from $20 to $25, per ton. ..... So far as the medicinal claim is concerned, ... even the treatment of a 'Quack' is better, and certainly cheaper, than the wholesale use of mixtures of unknown composition."—*Bul. 15, N. H. Expt. Sta., p. 3.*

Facts To Be Remembered.

(1) The mixture of ingredients contained in the ordinary foods comprises all that are known either to practice or science as useful to animal life.

(2) The ordinary cattle foods supply animal nutrition in the most useful and economical forms.

(3) Condimental foods are absurd as medicines. If an animal is well no medicine is needed, if ill, remedies adapted to the case should be administered.

(4) The farmer could manufacture his own "condimental" foods at a fraction of their usual cost, by mixing a small amount of such common sustances as salt, sulphur, saltpeter, fenugreek, caraway, &c., with the daily grain ration.

W. H. JORDAN.

MAINE STATE COLLEGE,
ORONO, ME., MARCH 25, 1895.

BULLETIN No. 21.

NOTES ON SMALL FRUITS.

The progress made in the culture of small fruits during the past twenty years has been rapid and substantial, but even at the present time the importance of this branch of horticultural work is not fully recognized by the people of the State. From the very nature of the soil and climate of Maine we must look to intensive rather than to extensive operations for the most profitable returns. At the present time there is no line of work which seems more promising than that of the culture of small fruits. With the increasing importance of our summer resorts, new and extensive markets are opened; while the operatives in the factories are always large consumers of fruit.

The purpose of this Bulletin and of succeeding ones is to give brief, concise hints on the culture of small fruits and information concerning some of the more important varieties.

The essential elements of success in small fruit growing are: suitable location; thorough preparation; the best varieties; careful planting; thorough culture; the application of business principles in marketing.

THE STRAWBERRY.

A warm, rather moist sandy loam is usually preferred in growing this fruit, but in general any soil that will raise a good crop of corn will raise good strawberries. I would not be understood as encouraging neglect in any way, but the minute directions sometimes given for preparing the soil and for planting are misleading and are enough to discourage any novice from attempting to grow fruit.

Thorough drainage, either natural or artificial, is absolutely essential, and thoroughness in the preparation of the soil is of prime importance, but the excessive applications of manure and the hand labor frequently advised are unnecessary. It is well to grow some hoed crop as corn or potatoes on the land for one or two years before setting the plants, as in this way there is less danger from attacks of the "white grub."

MAINE AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 21.

SECOND SERIES.

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grow some hoed crop as corn or potatoes on the land for one or two years before setting the plants, as in this way there is less danger from attacks of the "white grub."

The month of May is, perhaps, the best time for setting strawberry plants in this latitude, though good results often follow fall setting. Two very important considerations in setting the plants are that the crowns be just even with the surface of the earth and that the soil be pressed firmly about the roots. These points cannot be too strongly emphasized, for to their disregard may be traced more than half the failures in starting new plantings.

For general field culture the "matted row" system is probably best. The rows should be as long as convenient, that most of the labor of cultivating may be performed with a horse. The plants should be set eighteen inches apart in rows which are about four feet apart. Thus placed, a little more than seven thousand plants will be required for an acre. During the first season thorough culture should be practiced. It is also well to keep the runners cut back till the parent plants are strong and well developed.

Winter protection of the plants is always advisable. The value of such treatment is two fold: Not only are the plants protected from injury, but the fruit is kept clean and bright. The best material for the purpose is coarse meadow hay cut before the seeds have ripened. We have sometimes used "shingle edgings" with very satisfactory results. In the vicinity of large mills this material may often be obtained much more cheaply than the hay.

On light gravelly soils we have sometimes resorted to the use of boards on each side of the row of plants as illustrated below:

This device is found a very satisfactory means of conserving moisture and will permit the growth of plants in locations which would otherwise be unsuitable. Naturally this device is recommended only for the home garden.

The question of varieties, although of great importance, is one which must be settled largely by individual growers; for the success of any variety will frequently depend on local conditions. It is always a good plan to have a trial ground for the newer sorts, as varieties of much promise at the Experiment Station may prove worthless in some localities.

In selecting varieties for planting it is well to bear in mind the

distinction between the perfect flowering and the pistillate sorts. Many of our most valuable sorts are pistillate and must have some perfect flowering variety interspersed in order to secure the best results.

The following notes represent our estimate of the varieties fruited at the Experiment Station during the past two years:

Beeder Wood. (Perfect).—Small, spherical, uniform in size early in the season but soon "runs out." One of the earliest and most prolific sorts but of inferior quality. Plants quite subject to rust.

Beverly. (Perfect).—Large, oblong or spherical; of a rich dark color, moderately good quality, firm, prolific. A promising variety.

Bubach. (Pistillate).—Very large, irregular; of good color but poor quality, and lacking in firmness. Productive; valuable for near markets.

Charles Downing. (Perfect).—Of medium size, nearly spherical, moderately firm and of good quality. An old favorite for home use, but not as prolific as some others. Quite subject to rust.

Crawford. (Perfect).—Large, nearly spherical, uniform and regular; productive and of good flavor, but too soft and too light colored for market.

Crescent. (Pistillate).—An old and deservedly popular sort; but rather small and not of high quality.

Cumberland. (Perfect).—Plants vigorous and prolific; fruits large and of good quality, but too light colored and soft for market. One of the best for home use.

Dayton. (Perfect).—Medium to large, smooth and regular; of good quality but light colored and soft. Excellent for home use but too soft for market.

Epping. (Perfect).—Plants vigorous and prolific; fruit of medium size, roundish conical, uniform, bright red. A promising variety, received for trial from George Q. Dow, North Epping, N. H., under the name of "Yankee Doodle."

Gandy. (Perfect).—Of medium size, uniform, regular, firm and of good quality. Usually regarded as of special value as a late variety, but has not held its own with us.

Gen. Putnam. (Pistillate.)—Of medium size, but of pale color, soft and inferior in every way.

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Haverland. (Pistillate).—Medium to large, oblong, regular, firm and of good quality. Plants strong and vigorous; free from rust. A very good sort for general purposes.

Jessie. (Perfect).—An early sweet berry of good size. Oblong or conical, bright glossy red, handsome and of good quality. It has been one of the most satisfactory with us but is not uniformly reliable.

Jewell. (Pistillate).—Of medium size and uniform; but soft and of light color. Not prolific.

Leader. (Perfect.)—Medium size, roundish, bright red; fairly good quality. Only moderately productive.

Lovett. (Perfect).—Of the Crescent type. Early, prolific, but running small as the season advances and of second quality.

Michel's Early. (Perfect).—The earliest berry we have grown. Very productive, but small and of second quality. Blossoms very early and the flower trusses are short and well protected. Plants only moderately vigorous.

Mount Vernon. (Perfect).—Medium size, roundish conical, uniform. Of no special value.

Parker Earle. (Perfect).—Very productive, of large elongated fruit having a pronounced neck; firm and of good quality. The plants are very strong and vigorous, but send out few runners, hence should be planted thickly in the row. A valuable sort.

Princess. (Pistillate). Plant strong, vigorous and productive; fruit a little dull in color, but large, nearly spherical, uniform, moderately firm and of good quality. Medium to late in season. One of the best general purpose sorts.

Sharpless. (Perfect).—Plants vigorous and prolific. Fruit large but somewhat irregular and not always ripening evenly. Of good quality and always reliable.

Smeltzer. (Smeltzer's Early). (Perfect).—Sent for trial by F. H. Smeltzer, Van Buren, Ark. Plants vigorous, healthy and productive. Fruit uniformly of medium size, oblong, firm, of dark rich color and good quality. A promising early variety.

Swindle. (Pistillate).—As grown on our grounds the variety is rightly named. Plants strong and vigorous but not productive. Fruit of medium size, light colored and of very poor quality.

Van Deman. (Perfect).—An early variety; small, spherical; of rich dark color and good quality, but soft and not productive.

Warfield. (Pistillate or with abortive stamens).—Moderately vigorous. Flowers small on short truss and well protected by foliage. Fruit of medium size, firm texture, moderately good quality; ripens evenly, holds its size through the season. Its deep rich color and productive habit make it one of the most valuable market sorts.

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The best of the older varieties above named are: Bubach, Crescent, Haverland, Sharpless and Warfield, with possibly Beeder Wood or Michel's as very early perfect flowering sorts.

Of the newer varieties the following deserve special mention: Beverly, Dayton, Epping, Gillespie, Greenville, Parker Earle, Princess, Smeltzer.

W. M. MUNSON.

MAINE STATE COLLEGE,
ORONO, ME., April 15, 1895.

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W. M. MUNSON.

MAINE STATE COLLEGE,
ORONO, ME., April 15, 1895.

BULLETIN No. 22.

INSPECTION OF FERTILIZERS.

W. H. Jordan, Director.

J. M. Bartlett, L. H. Merrill, Chemists.

This bulletin is the second to be issued during the year 1895 giving a report of the official inspection of fertilizers. The first bulletin, No. 18, was published on March 9th, and gave the results of the analyses of Manufacturer's Samples. These samples were furnished by the manufacturers for inspection accompanied by an affidavit that they were like the goods which they represented "within reasonable limits."

The samples mentioned in this bulletin are almost wholly those selected by a Station representative at different points in the State from goods which were exposed or offered for sale. These samples were very carefully taken in accordance with the provisions of a law which seeks to guard the rights of the manufacturers, and they certainly represent the particular lots of goods from which they were selected.

The main purpose of selecting samples from the various brands of fertilizers as found in the open market is to ascertain if the goods actually on sale meet the requirements of the manufacturer's guarantees, and whether the manufacturer's samples, whose analyses are published in the Spring bulletin, are to any extent a safe guide in the purchase of fertilizers.

The comparison which follows shows very plainly what are the facts. It may be said that on the whole it appears that the manufacturers intend to deal fairly with the public in the matter of their guarantees, remembering always, of course, that no manufacturer can be held to have guaranteed more than the minimum percentage in which any ingredient is stated to be present.

Notwithstanding certain sarcastic, and we can but believe, unfriendly criticisms, because this Experiment Station decided to drop the system of commercial valuations, there is no present intention of receding from that decision. There are already indications that farmers who are disposed to put intelligence into their business will themselves, through the information furnished by the Station, make such calculations as are necessary for their choice of the brand which they can most economically purchase and will in that way understand the situation as they could in no other way; and it is obvious that to those farmers who are so careless or uninformed as not to do this, the valuations made by the Station are likely to be nothing but a stumbling block.

Any system of aiding the farmer which is merely mechanical and which leaves out of account a proper study on his part of the

facts with which he has to deal is false in theory and less helpful in practice than it should be.

(The bulletin gave the manufacturers guarantees and the analyses of manufacturer's samples, but as these figures have only a passing value they are omitted here. The comments on the results of the inspection follow, however. W. H. J.)

A comparison is made of the samples selected by a Station representative, the manufacturer's samples and the minimum guarantees.

The important considerations are the following:

(1.) Fifty-seven brands are involved in this comparison.

(2.) The averages for nitrogen are: Guarantee, 1.99 per cent., manufacturer's sample, 2.14 per cent., Station sample, 2.09 per cent. For available phosphoric acid the averages are: Guarantee, 7.84 per cent., manufacturer's sample, 9.05 per cent., Station sample, 8.58 per cent. For potash: Guarantee, 3.31 per cent., manufacturer's sample, 3.60 per cent., Station sample, 3.42 per cent.

(3.) In the fifty-seven brands, the Station sample as compared with the manufacturer's sample was, in nitrogen practically the same twenty-three times, poorer twenty-two times and better twelve times; in available phosphoric acid, practically the same fourteen times, poorer thirty-one times and better twelve times; in potash, practically the same sixteen times, poorer twenty-four times and better seventeen times.

(4.) Comparing the *Station sample* with the *minimum guarantee*, the Station sample was, in nitrogen, practically the same twenty-seven times, poorer nine times, better twenty-one times; in available phosphoric acid, practically the same twenty times, poorer seven times, better thirty times; in potash, practically the same seventeen times, poorer fourteen times, and better twenty-six times.

It is quite customary for manufacturers to state a minimum and a maximum guarantee for the percentages of the ingredients of their goods, as for instance the guarantee for available phosphoric acid would be eight to ten per cent. The above comparisons indicate that the manufacturers do not intend to do much more than make good the minimum guarantee, and that this is all the purchaser can safely expect.

It is gratifying to note that as a rule the fertilizers sold in the State are well up to this guarantee. Indeed, there is no case which appears to be an attempt to defraud, although in a few instances the particular lots of goods sampled are not quite as good as they should be.

MAINE STATE COLLEGE,
Orono, Me., 1895.

FERTILIZER LAW IN FORCE IN MAINE.

PUBLIC LAWS OF MAINE, 1893.

CHAPTER 256.

AN ACT to regulate the sale and analysis of Commercial Fertilizers.

SECTION 1. Every manufacturer, company or person who shall sell, offer or expose for sale in this state any commercial fertilizer or any material used for fertilizing purposes, the price of which exceeds ten dollars per ton, shall affix to every package of such fertilizer in a conspicuous place on the outside thereof, a plainly printed statement clearly and truly certifying the number of net pounds in the package sold or offered for sale, the name or trade mark under which the article is sold, the name of the manufacturer or shipper, the place of manufacture, the place of business and a chemical analysis stating the percentage of nitrogen, or its equivalent in ammonia in available form, of potash soluble in water, and of phosphoric acid in available form, soluble and reverted as well as the total phosphoric acid.

SECT. 2. Every manufacturer, company or person who shall sell, offer or expose for sale in this state any commercial fertilizer or material used for fertilizing purposes, the price of which exceeds ten dollars per ton, shall for each and every fertilizer bearing a distinguishing name or trade mark, file annually with the director of the Maine Agricultural Experiment Station, between the fifteenth day of November and the fifteenth day of December, a certified copy of the statement, named in section one of this act, said certified copy to be accompanied, when required, by a sealed glass jar or bottle containing at least one pound of the fertilizer to be sold or offered for sale, and the company or person filing said certified copy with its accompanying sample of fertilizer shall thereupon make affidavit that said sample corresponds within reasonable limits to the fertilizer which it represents in the percentage of nitrogen, total and available phosphoric acid, and potash soluble in water which it contains. Such affidavit shall apply to the entire calendar year next succeeding the date upon which said affidavit is made, unless the person or persons making such affidavit shall give notice to the

director of the Maine Experiment Station that a change is to be made during the year in the percentages of the above named ingredients contained in the fertilizer, in which case he shall, before selling or offering for sale such fertilizer, file another certified statement with an accompanying sample of fertilizer and an affidavit as hereinbefore required. The deposit of a sample of fertilizer as herein provided shall be required by said director unless the company, manufacturer or person selling or offering for sale a fertilizer coming within the provisions of this act, shall certify that its composition for the succeeding year is to be the same as given in the last previously certified statement, in which case the requiring of said sample shall be at the discretion of said director.

SECT. 3. The director of the Maine Experiment Station shall analyze, or cause to be analyzed, all the samples of fertilizers which come into his possession under the provisions of section two of this act, and shall publish the results thereof in a bulletin or report on or before the fifteenth of March next succeeding.

SECT. 4. Any manufacturer, importer, agent or seller of any commercial fertilizer, who shall deposit with the director of the Maine Experiment Station a sample or samples of fertilizer under the provisions of section two of this act, shall pay annually to said director an analysis fee as follws: Ten dollars for the phosphoric acid and five dollars each for the nitrogen and potash, contained or said to be contained in the fertilizer, this fee to be assessed on any brand of which thirty tons or more are sold in the state, and upon receipt of such fee and of the certified statement named in section two of this act, said director shall issue a certificate of compliance with this act. Whenever the manufacturer or importer of a fertilizer shall have filed the statement made in section two of this act and paid the analysis fee, no agent or seller of said manufacturer, importer or shipper shall be required to file such statement or pay such fee. The analysis fees received by said director shall be paid immediately by him into the treasury of said experiment station.

SECT. 5. Any manufacturer, importer or person who shall sell, offer or expose for sale in this state any commercial fertilizer without complying with the requirements of sections one, two and four of this act, or any fertilizer which contains substantially a smaller percentage of constituents than are certified to be contained, shall, on conviction in a court of competent jurisdiction, be fined one hundred dollars for the first offence, and two hundred dollars for each subsequent offence.

SECT. 6. The director of the Maine Experiment Station shall annually analyze, or caused to be analyzed, at least one sample, to be taken in the manner hereinafter presribed, of every fertilizer sold or offered for sale under the provisions of this act. Said director is hereby authorized and directed in person or by deputy to take a sample, not exceeding two pounds in weight, for said analysis, from

any lot or package of fertilizer or any material used for manurial purposes which may be in the possession of any manufacturer, importer, agent or dealer in this state; but said sample shall be drawn in the presence of said party or parties in interest, or their representative, and taken from a parcel or a number of packages which shall not be less than ten per cent. of the whole lot sampled, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn and the time and place of drawing, and said label shall also be signed by the director or his deputy and by the party or parties in interest or their representative at the drawing and sealing of said samples; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled; and the sample or samples retained by the director shall be for comparison with the certified statement named in section two of this act. The result of the analysis of the sample or samples so procured shall be published in a report or bulletin within reasonable time.

SECT. 7. Whenever the director becomes cognizant of the violation of any of the provisions of this act he shall report such violation to the secretary of the board of agriculture, and said secretary shall prosecute the party or parties thus reported; but it shall be the duty of said secretary upon thus ascertaining any violation of this act, to forthwith notify the manufacturer or importer in writing, and give him not less than thirty days thereafter in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of any fertilizer or fertilizing material if the same shall be found substantially equivalent to the certified statement named in section two of this act.

SECT. 8. All acts and parts of acts inconsistent with this act are hereby repealed.

SECT. 9. This act shall take effect when approved.

Approved March 14.

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