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Insects Injurious to the Cabbage ; A new Method for Testing Milk ; Feeding for Milk and Butter.

Howard Evarts Weed

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MISSISSIPPI

Agricultural and Mechanical College

EXPERIMENT STATION.

BULLETIN NO. 21.

I. Insects Injurious to the Cabbage.

II. A New Method for Testing Milk.

III. Feeding for Milk and Butter.

AGRICULTURAL COLLEGE, MISS.

JUNE, 1892.

INSECTS INJURIOUS TO CABBAGE.

HOWARD EVARTS WEED.

The cabbage crop of the south is especially subject to damage by insects, the species described in this bulletin having been observed on the crop grown at the Station in 1891. The aim has been to make the description of each species concise, but at the same time to give sufficient of the characteristic appearance of each to enable those interested to readily recognize the different kinds attacking their cabbage, and the accompanying illustrations will aid much toward this end. Part of the illustrations have been obtained from the U. S. Department of Agriculture, through the kindness of Dr. Riley. Figs 1, 3-12, 16, 17-18, are after Riley; Fig. 13 after C. M. Weed; while Figs. 2, 14, 15, are original. A straight line at the side of an illustration indicates the natural length of the insect. The safe and economical destruction of these pests is of great practical importance and the remedies given are those which have proved of value in our hands.

THE IMPORTED CABBAGE WORM. *(Pieris rapæ*, Linn.*)*

This insect was imported from Europe, being first noticed in this country in Quebec in 1859. From that point its spread southward and westward was very rapid and now it is quite generally distributed throughout that portion of the United States lying east of the Rocky Mountains. This species has largely taken the place of its kindred native species *protodice.*

DESCRIPTION.—The adult form of this insect is the white butterfly so often seen flying here and there among the cabbages. The female butterfly, shown at *c* in Fig. 1, differs from the male by having two black spots upon the forewings, while the latter has but one. The butterfly is so well known that a more complete description is unnecessary and it can be readily recognized from the accompaning illustration. The chrysalis, shown at *b,* is about one-half

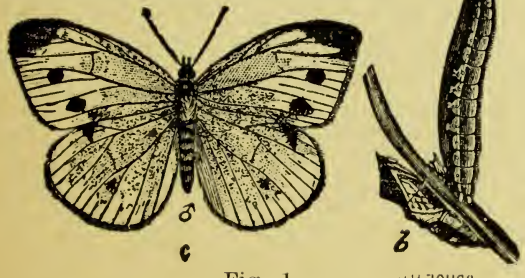

Fig. 1.

an inch in length and of a light green color. It is angular in outline and pointed at both ends. The larva, shown at *a*, is a dark green caterpillar and is nearly an inch in length when full grown. The body is covered with fine light hairs, those upon the back and sides having a light yellow tinge.

The yellow eggs are usually deposited singly, on the underside of the cabbage leaves, and, upon hatching, the young larvæ begin their work upon the leaves. Upon examination of infested cabbage plants the larvæ may be found on the inner leaves toward the head. In about two weeks the larvæ reach maturity, when they form the chrysalides, either on the underside of the outer leaves or upon boards or protected surfaces in the immediate vicinity, and in another week the butterflies come forth, thus completing the cycle of life. There are several broods of this insect during a season and, in this latitude, the first butterflies appear about the first of March and continue to appear until December. The winter is spent as a chrysalis.

PARASITES.—In Europe, where this insect is exceedingly common, there are many parasites which hold it in check. Its rapid distribution in this country is no doubt owing to the absence of its European parasites. It has several parasites here, however, and one of them, a hymenopterous insect, *Pteromalus puparum*, is especially abundant. Out of forty-six chrysalides collected in February from the walls of the Station forcing house, but nine hatched butterflies, the rest hatching large numbers of the parasite. This shows that the greater majority of these insects are parasitized, but there are still enough representatives hatched to continue the species.

The *Pteromalus puparum*, shown at Fig. 2, is a small, black, four-winged, fly-like insect which lays its eggs in the larvæ and chrysalides of the cabbage butterfly. A chrysalis containing the parasites can be readily distinguished by being more brittle and of a lighter color, while a chrysalis not parasitized is light green in color and has the abdomen of the body freely movable. The worm is also often destroyed by a bacterial disease which, when present in an infested field, kills off the caterpillars very rapidly.

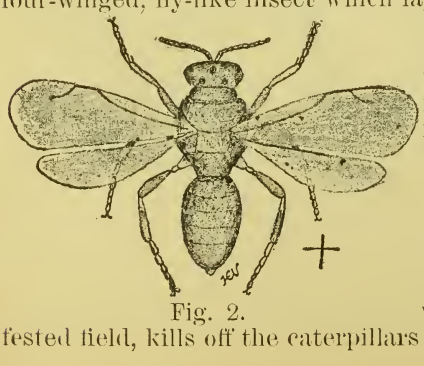

Fig. 2.

THE SOUTHERN CABBAGE BUTTERFLY. *(Pieris protodice*, Boisd.)

This species is a native of this country and, until a few years ago, was the best known cabbage butterfly. Of late, however, the imported species has gradually pushed it to the wall, but it still occurs in small numbers throughout the southern and middle states.

DESCRIPTION.—The adult female of this insect is shown in Fig. 3, and the male in Fig. 4. As seen from the illustrations it differs much in markings from the imported species. The larva is readily distinguished from the *rapæ* larva by four yellowish stripes and dark spots along the body. When first hatched it is of a yellow color, becoming brown before the first moult, the yellow stripes appearing after this moult.

Fig. 3.

The life history and habits of this species are much the same as those of the imported cabbage worm, except that this species usually feeds only upon the cabbage, while the imported species feeds upon other cruciferous plants.

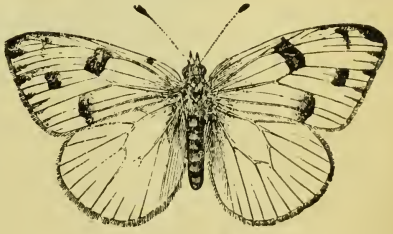

Fig. 4.

THE LARGE CABBAGE BUTTERFLY. *(Pieris monuste*, Linn.)

This is a larger species than the foregoing and is essentially a southern insect, which abounds throughout the southern states as well as in the West Indies and Surinam.

DESCRIPTION.—The mature form of this insect is represented at *c*, in Fig. 5. The upper surface of the front wings is white,

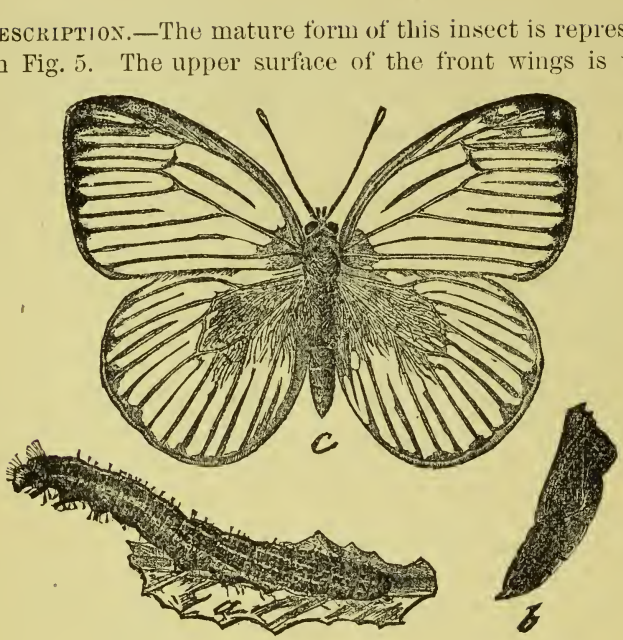

Fig. 5.

bordered with black, and the hind wings are white in the male, while the female has a black line on the middle of the front wings and a few triangular spots on the hind wings. The larva, shown at *a*, in Fig. 5, is about an inch in length, of a yellow color and has four longitudinal stripes. The body is covered with black spots and also bears many bristles. The chrysalis, shown at *b* is yellowish and has two spines on the middle of the body.

This species feeds upon a variety of plants besides the cabbage and, although not common, in some localities it occurs in large numbers.

THE CABBAGE PLUSIA. (*Plusia brassicæ*, Riley.)

This insect is exceedingly common in the southern states and feeds upon a variety of plants besides the cabbage, such as celery, cauliflower, lettuce, turnip, and tomato. Upon the cabbage

it is quite common, especially upon the young plants, and towards the close of the season, when the insect in all stages of larva, pupa, and imago can be found in an infested field.

DESCRIPTION.—The adult form of this insect is a moth, shown at *c* in Fig. 6, resembling the cut-worm moths very much. The body and hind wings are light brown while the front wings are darker, varigated, with a silver spot near the center. The outspread wings measure nearly one and one-half inches and the body three-fourths of an inch. The moth usually flies at twilight or in the night, but is occasionally seen about the cabbage plants on cloudy days. The brownish pupa, shown at *b*, is about one-half inch in length and is enclosed within a mass of silk. It may be found within the lower leaves which are folded over upon the lower side. The larva shown at *a*, measures an inch in length when full grown and is a "looper" as is shown in the illustration, with the central portion of the body raised. It is usually green with light stripes, though occasionally the stripes are wanting. The greenish-yellow eggs are deposited upon the upper or lower side of the leaves, either singly or in clusters. Upon hatching, the larvæ eat holes into the leaves, occasionally eating into the head. Their depredations are especially noticeable late in the season upon cabbages set out in September. The larvæ are three weeks attaining their full growth and the length of time spent in the pupal state is about two weeks. There are about six broods in a season, the first moths appearing late in March.

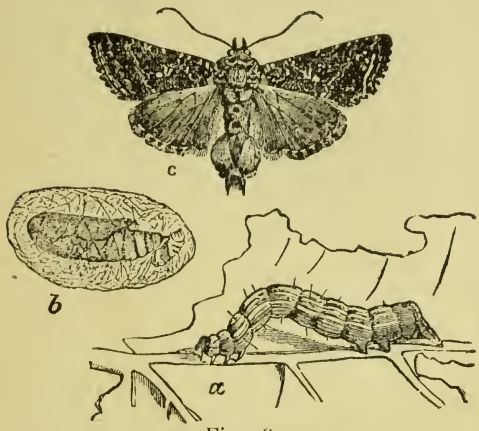

Fig. 6.

PARASITES.–Several ground beetles and a number of birds prey upon this insect and it is also destroyed by a bacterial disease. The most formidable parasite is *Copidosoma truncatellum*, a hymenopterous insect which is shown in Fig. 7. This parasite lays its eggs in the *Plusia* larvæ, upon which the larvæ of the parasite feed. An attacked *Plusia* larva has the characteristic appearance shown in Fig. 8, being pale yellow in color and very sluggish in its movements. By an actual count Dr. Riley states that 2,528 of these parasites emerged from a single *Plusia* larva. These parasites were very numerous at the Station last season, causing many of the *Plusia* larvæ to die before becoming pupæ.

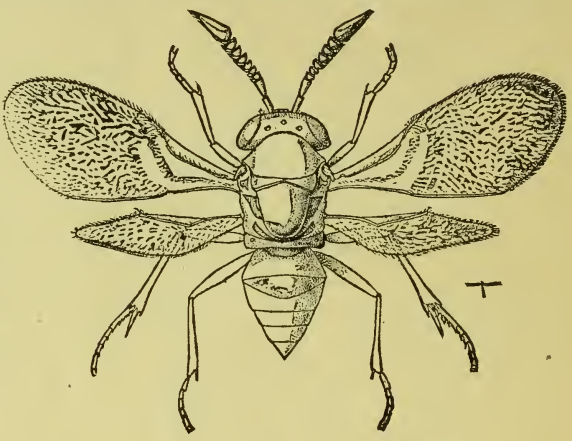

Fig. 7.

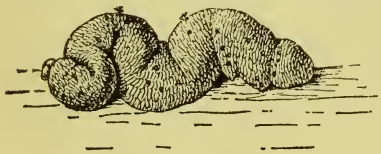

Fig. 8.

THE ZEBRA CABBAGE WORM. (*Mamestra picta*, Harris.)

The larva of this insect can be readily distinguished from the other cabbage worms by the brilliant yellow and black markings upon the body. This insect is quite common in some localities and was present in small numbers in the cabbage fields of the Station last season.

DESCRIPTION.—The imago of this insect is a brown moth, shown at *b*, in Fig. 9. The front wings are purple brown with a prominent spot in the center, fringed with white, while around the edges of the wings are small white spots. When first hatched the worms are nearly black and feed together upon a leaf, but as they become older they assume a pale green color and feed singly. When disturbed they curl up and drop to the ground. They become full grown in from two to three weeks, when they are nearly two inches in length with a wide longitudinal velvet-black stripe along the back, with two narrow yellow stripes on each side, between which occur fine yellow transverse lines. A full grown larva is shown at *a*. The larvæ pupate under about two inches of earth within a rude covering formed of earth held together by silken threads. In about two weeks the moths come forth, and in this latitude there are probably three broods in a season, the winter being spent in the pupa state. This insect is a very general feeder occurring upon asters, asparagus, honeysuckle, peas, and many other plants besides the cabbage.

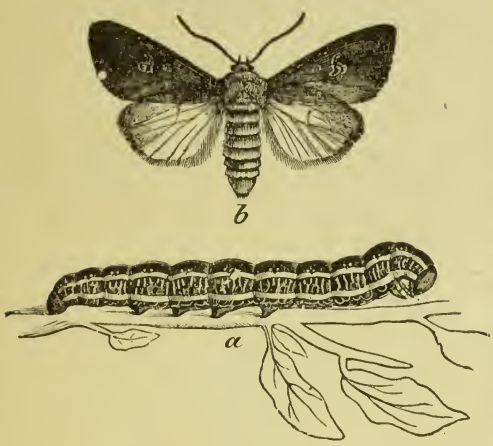

Fig. 9.

THE CABBAGE EVERGESTIS. (*Evergestis rimosalis*, Gn.)

This insect is essentially a southern species, it being quite common throughout the south and extending as far north as Illinois. Like some of the other cabbage insects it is not content with eating the outer leaves, but bores into the head as well.

The moth which lays the eggs is shown at *c* in Fig. 10. The general color is ocher-yellow with the margins of the front wings darkened towards the tip, and the basal portion of the hind wings nearly transparent. The larva, shown at *a*, is quite slender measuring about three-fourths of a inch when full grown. The body is purplish-brown above and green beneath, with several white transverse

Fig. 10.

lines and a yellow longitudinal line along the side. The pupa, shown at *b*, is formed at the surface of the soil and is of a dark-brown color at the head and wing cases, with a lighter colored abdomen.

There are several broods in a season and the damage done by this species is quite marked, both owing to its being quite common, and its habit of boring into the heads. It feeds upon other Cruciferæ as well as the cabbage.

THE CABBAGE PLUTELLA. (*Plutella cruciferarum*, Zell.)

Owing to its small size this insect is apt to be overlooked and its larvæ might easily be mistakened for young larvæ of the white butterflies. It is well distributed throughout the eastern United States and, like most other insects infecting the cabbage, feeds upon other related plants, as the turnip.

The larva, shown at *a*, in Fig. 11, is an active pale green worm measuring slightly over one-fourth inch in length. When disturbed it wriggles about, drops from the leaf and hangs suspended by a silken thread. The larva pupates within a small delicate cocoon shown at *e*, through which the pupa case can be readily seen. The cocoon and its pupa resemble somewhat those of the cabbage Plusia, but it is much smaller and more delicate. The small ash gray moth, shown at *f* and *h*, which resembles in form and size the well known Angoumois grain moth, hatches from the pupa in about two weeks. There are at least three, and probably more broods of this insect in a season, the moths being noticed the present season as early as February 28th. The larvæ feed mostly upon the outer leaves, doing but little damage to the heads especially if the latter are compact.

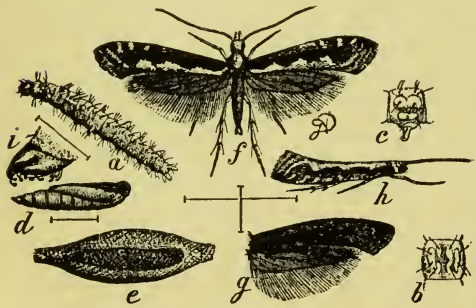

Fig. 11.

REMEDIES.—There are many successful remedies for the insects treated of in the foregoing pages, nearly all of which are very simple. The larvæ are all leaf feeders and can be reached

either by poisons to be taken into the system or by external irritants. As cabbages are used for food it is not advisable to apply poisons to the plants after they have begun to head, but they can be freely applied without danger before this time.

Paris green mixed with fifteen to twenty times its weight of flour and applied dry is an excellent application for the plants when in the cold-frame or a short time after they have been set in the field. It can also be applied to advantage in water, a teaspoonful to the pail, by means of a knapsack pump or hand force pump. Hot water is a good application for the cabbage worms. It can be applied quite hot without injury to the plants but will kill the larvæ with which it comes in contact.

Pyrethrum applied in the same manner as described for Paris green is a very simple remedy. This substance consists of the powdered leaves and flowers of the pyrethrum plant and can be obtained at the drug stores under the name of Persian or Dalamatian Insect Powder at a cost of about thirty-five cents a pound; while that grown in California costs about seventy-five cents a pound, and is of a better quality. The Pyrethrum is not poisonous, but kills by closing the breathing pores of the skin, and hence makes an efficient yet a harmless insecticide, especially valuable against cabbage worms.

Kerosene emulsion is an excellent remedy for all cabbage insects, but it is not best to apply it to plants which have formed heads, owing to danger of tainting. The emulsion is best applied in the form of a spray by means of a knapsack pump. It should be applied directly to the insects as it kills by irritation and not by poisoning.

Various forms of spraying apparatus are described in Bulletin 14, copies of which will be sent to those desiring it.

CABBAGE CUT-WORMS.

When cabbage plants are first set out in the field from the cold-frame they are liable to attack from various cut-worms which cut off the stems at the surface of the soil. They are so well known that a description of them is unnecessary. Their mature forms are the brown moths so common about lights.

The eggs of most cut-worm moths are deposited upon trees and shrubs and, upon hatching, the larvæ descend to the ground

in search of food. They feed principally upon grass when young. Upon the approach of winter they are nearly full grown and hybernate in grass, under boards, logs, and the like, and in the early spring come forth in search of food. They then feed upon a variety of plants, biting off the stems and feeding upon the leaves.

A common cut-worm, the dark-sided one, (*Carneades messoria*, Harris,) is shown in Fig. 12, *a* representing the larva and *b* the imago.

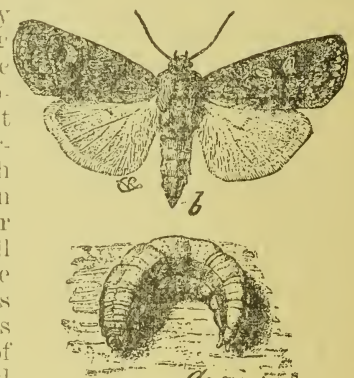

Fig. 12.

REMEDIES.—A common remedy consists in wrapping the young plants with paper when they are set out. Although this affords protection to the plants, a more recent remedy—that of poisoning the larvæ by means of bait traps—is much better. Bunches of freshly mown grass or clover are dipped into water into which has been mixed a small amount of Paris green, and these are placed about in different parts of the cabbage field. The cut-worms will gather under these and eat of the poisoned grass, and the dead larvæ may be found under about an inch of soil where these poisoned bunches have been placed. This is an efficient remedy, as a thorough trial will readily prove.

THE CABBAGE APHIS. (*Aphis brassicæ*, Linn.)

The cabbage aphis has been known in this country since 1791 and was probably brought from Europe soon after its host plant. It is well distributed throughout the United States and this season is especially abundant upon the cabbages at the Station grounds.

DESCRIPTION.—The cabbage aphis is a small greenish insect with a white mealy excretion covering the body. They are found either singly or in clusters on the underside of the leaves, or near the center of the forming head.

The form most commonly seen is the wingless form which gives birth throughout the season to living young. Besides this

form there is also the winged viviperous female, the apterous oviperous female, shown at *c*, in Fig. 13, and the winged male, shown at *a*. Throughout the season only the wingless and winged females are found, which, from time to time, give birth to living young. The increase of the aphides is very rapid, so much so that a single female may become the progenitor of many million lice during a season. Occasionally winged females are produced which may migrate to other fields. In autumn true males and females are produced and, after pairing, the winter eggs are laid upon the old cabbage leaves. However, if a suitable food plant is obtained the viviperous females will continue throughout the winter. On the Station grounds the past winter the aphides were to be found upon growing cabbage plants at all times. Young plants were set out early in December and the aphides soon made their appearance upon them and survived the winter although the thermometer registered as low as fifteen degrees Fah. The aphis feeds upon a variety of plants such as radish, mustard, and turnip, as well as upon the cabbage.

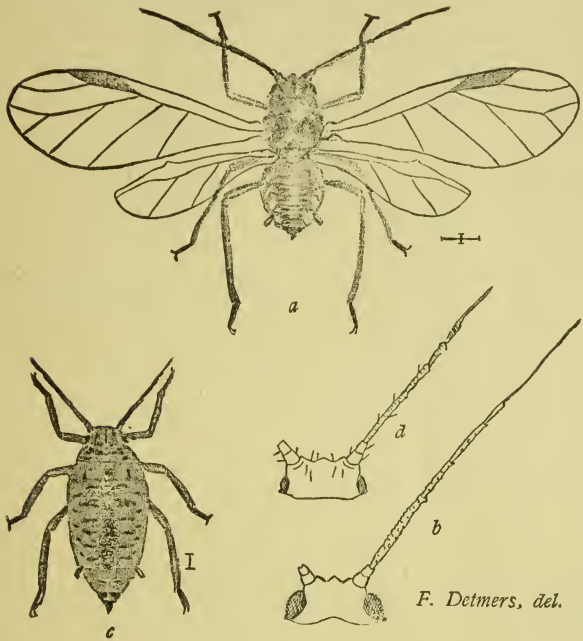

Fig. 13.

PARASITES AND REMEDIES.—There are many parasites which prey upon this insect and tend to hold it in check to a very large extent. The most common at the Station this season are the larvæ of a fly belonging to the genus *Syrphus*, and a small hymenopterous insect *Trioxys pieeus*, Cress., the latter being especially common. The Syrphus larvæ are footless grubs about one-third of an inch in length. The ventral surface of the body is flat and

the body tapers from behind forward. These larvæ destroy large numbers of the plant lice by inserting their mouth parts into the bodies of the lice and extracting their life blood. The other parasite is a small fly-like insect shown in Fig. 14, which can be often seen among the cabbage aphides. This parasite lays its eggs in the bodies of the plant-lice and the larvæ hatching from them feed upon the aphides. In this manner Nature checks a too great increase of the aphides.

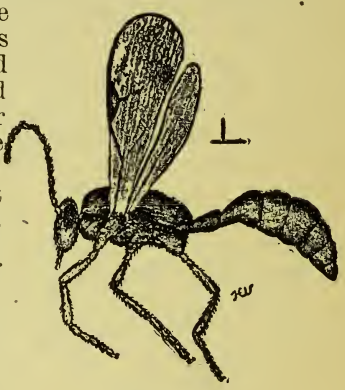

Fig. 14.

The lady-beetles are of great importance in keeping the aphides in check, as their food consists largely of plant-lice. A common form of this is the Convergens beetle, shown in Fig. 15. This beetle was found to feed upon the cabbage leaves to some extent last season but it is probable that this habit is only developed in the absence of the plant-lice.

Fig. 15.

The cabbage aphides are very easily destroyed by the application of any of the external irritant insecticides. Kerosene emulsion is the best for this purpose, and is best applied by means of a knapsack pump. It should be applied directly to the insects and kills by penetrating the skin. Pyrethrum in water, a tablespoonful to the pail, is very efficient, and tobacco decoction, made by boiling refuse tobacco in water, is also excellent.

THE HARLEQUIN CABBAGE BUG. (*Murgantia histrionica*, Hahn.)

This is by far the worst cabbage pest of the South, not because it is more numerous than the other cabbage insects, but because it is the hardest to destroy. It is quite generally distributed throughout the southern states and is rapidly spreading northward. It is probably a native of some southern country—Central America or Mexico—it being first noticed in this country in Texas in 1866.

DESCRIPTION.—The harlequin cabbage bug receives its common name from the reddish-yellow markings upon the body. The mature insect is a beautiful creature measuring two-fifths of an inch in length and one-third of an inch in breadth. The various stages of this insect are shown in Fig. 16, *f* and *g* representing the mature form. The general color of the insect is black but the thorax and wing cases bear yellowish-red markings while the under surface of the body is spotted with white and yellow. The pupa,

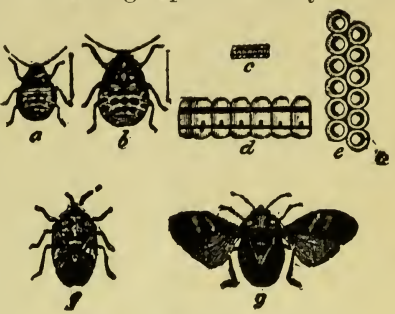

Fig. 16.

shown at *b*, differs from the mature form in being smaller, without wings and but four jointed antennæ while in the imago the latter are five jointed. The larva, shown at *a*, is quite small and slightly more yellow than the pupa. The eggs resemble a miniature barrel both in shape and markings. They are laid on the underside of the leaves in a double row as is shown at *e*. The usual number laid in a batch is twelve, but occasionally more than this number are laid, in which case they are arranged cylindrically—sometimes as many as twenty-seven together. The eggs are white with a slight greenish tinge and marked with black on the side and ends as shown at *d* and *e*.

LIFE HISTORY AND HABITS.—The harlequin cabbage bug spends the winter in the adult state, and the eggs for the first brood are laid the latter part of March upon radish and mustard plants. On the first warm days in March they congregate in large numbers upon these plants near the old cabbage fields. Egg laying commences the day following mating and extends over a period of at least ten days for each female. The length of time before the eggs hatch varies from two to eight days and as soon as hatched the young bugs begin their work of destruction by inserting their beaks and sucking the juice from the plant. They increase in size rapidly, shedding the skin several times during growth, and reach maturity in about three weeks after the eggs are laid. The length of time required for growth, however, varying from two to four weeks depending upon the temperature. Occasionally the eggs for the first brood are laid upon the cabbages, but as a rule cabbages are not attacked until the eggs for the second brood have hatched. The second brood

is much more numerous than the first and it is this brood that does the most damage. The insects make their appearance in large numbers just as the plants are beginning to head and, by their work in sucking the juices, cause the plants to become withered and useless. There are three or four broods in a season and the bugs are especially abundant upon fall cabbages.

REMEDIES.—There is but one efficient remedy for this insect, which is to destroy the brood which lives over winter when they congregate upon the mustard or radish plants. Here they can be destroyed very easily by the application of kerosene by means of a hand force pump or common watering bucket. If the insects are thus destroyed early in the season it will almost wholly prevent injury later. The insects fly but little and are thus not apt to come from a neighbor's field. Hand picking should be practiced upon the first appearance of the bugs upon the cabbages, and if any eggs are noticed these should also be picked off. The bugs and eggs are readily killed by placing them in kerosene. It is useless to try to kill these insects with Paris green or London purple or other insecticides which kill by being eaten, as they feed by suction, placing their beaks into the plant out of the reach of any poisons which may be applied to the surface. Kerosene emulsion is fairly successful in destroying the larval form. Diluted to its usual strength (that is, so that one-fifteenth part is kerosene), it is of no value in destroying the mature insect and when used with a greater proportion of kerosene the plant is damaged. It is thus seen that a substance extensively used for insects similar to the harlequin cabbage bug, is of but little value against this insect.

Our present crop of cabbage was put into the field early in March, and at the same time a row of radishes was planted through the middle of the patch. The radishes were well grown by the time the second brood of bugs had hatched, and nearly all the insects soon found their way to the radishes, where they were killed by spraying with kerosene. At this date, June 15, hardly a single bug is to be found in this patch, while cabbage planted in other parts of the grounds are badly infected.

THE CABBAGE MAGGOT. (*Anthomyia brassicæ*, Bouche.)

The mature form of this insect is a small two-winged fly somewhat smaller than the common house fly, and of a more uniform color, and is shown at Fig. 17. The flies make their appearance early in the season and deposit their eggs around the stem of the cabbage near the surface of the soil. The eggs hatch into maggots which penetrate and feed upon the stem just below the surface of the soil. The maggots, one of which is shown at *a*, are white, about one-fourth inch in length and reach maturity in about three weeks, when they form brown puparia as shown at *b*.

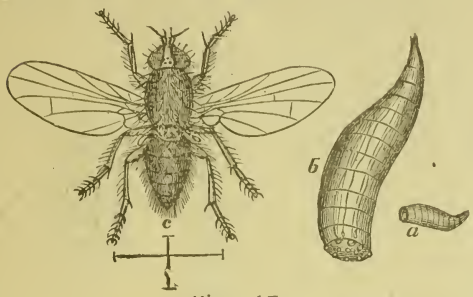

Fig. 17.

In this latitude there are several broods in a season, the insect passing the winter in either the larval, pupal, or imaginal states.

The damage done by this insect in some localities is quite marked, as by their work they retard growth and the plants do not head. If this condition of affairs exists the plants should be examined carefully about the roots to ascertain if the maggots are present. A dozen maggots may sometimes be found about and within one stem and roots, when they sometimes cause a swelling giving a similar appearance to that caused by a fungus producing the disease known as "Club root." The maggots feed also upon the turnip, and the radish maggot is probably the same species.

REMEDIES.—The remedies generally recommended for this pest consist of the application of lime, ashes, and the like around the stems. Recently, however, Prof. James Fletcher, Dominion Entomologist of Ottawa, Can. has shown the following to be a very efficient remedy: Two ounces of hellebore are steeped in three gallons of water, and by means of a small force pump the liquid is applied to the roots after first scraping away about two inches of earth. This should be applied as soon as the maggot attack is noticed and if an assistant scrapes away the dirt from each plant and replaces it as soon as treated, it will require but little labor to go over a large field. Kerosene emulsion applied as above is also effectual, and a knapsack pump will be found an excellent means for applying either, the stop-cock being turned as each plant is treated.

THE WAVY-STRIPED FLEA-BEETLE. (*Phyllotreta vittata*, Fab.)

This is the small shining black beetle so common upon most garden crops. It attacks cabbages especially and the mature insect does its damage by eating small pits into the leaves while the larvæ feed upon the roots. This insect is shown in Fig. 18, *a* representing the larva and *b* the imago. The larva is about one-fourth of an inch in length with a yellowish-white body and brown head. The beetle is one-tenth inch in length, oval, shining black excepting two broad yellow wavy lines upon the wing cases. The eggs are deposited by the female beetles upon the roots of many garden plants, upon which the young larvæ feed, often doing considerable damage. There are at least two broods a season, the beetles being most common in June and July. The larvæ of a similar species (*Phyllotreta zimmermanni*, Crotch), feed upon the leaves, but this species is not common here.

Fig. 18.

REMEDIES.—If refuse tobacco is applied to the plants and about the roots, it will act as a preventive against these pests, and a tobacco decoction made by boiling or soaking tobacco in water, is also a good remedy. If the larvæ are very numerous about the roots, kerosene emulsion, applied as described for the cabbage maggot, will prove efficient.

A New Method for Determining the Amount of Butter Fat in Milk.

L. G. PATTERSON.

Bulletin No. 15 of this Station, published in June, 1891, gives results of tests of the Beimling, Babcock, and Patrick methods for testing the amount of butter fat in milk, as compared with the very accurate "paper coil" gravimetric method of Adams. The results of the work published a year ago were summed up as follows:

"The Beimling method requires less time than does either of the others, but the scale on the bottles is not as easy to read, and no means are provided for keeping the fat in a melted condition.

The Babcock has the best bottles, but requires more time for its operation, and it is absolutely necessary to have the specific gravity of the acid 1.82.

The Patrick method is very convenient where a large number of tests are to be made, but it requires considerable time to heat the bath, and the bottles are very easily broken.

By referring to the above table it will be seen that all of the methods give fairly accurate results, but in the majority of the cases the methods of Beimling and Patrick tallied more nearly with the gravimetric, while the Babcock fell slightly low, but not enough so to injure the value or accuracy of the method for practical work."

Since the completion of the work published in Bulletin No. 15, we have been endeavoring to find some method by which we could secure results as nearly accurate as those of the Beimling, without the disadvantages attending the use of that method, and recognizing the excellence of the Beimling machine, we have used that and its accompanying bottles in our further work.

Any volumetric method should have the following characteristics to make it desirable for general use, viz:

1. Accuracy.
2. Simplicity.
3. Rapidity, enabling the operator to make any number of tests in a relatively short time.
4. Cheapness.

Any method which contains a constant source of error such as the charring of the fat column; or one which is unduly expensive in either time or in chemicals, is, to that extent, undesirable. After many trials, the method which we finally adopted, and which was used in making the determinations reported in this bulletin, is as follows:

APPARATUS. 1. A Beimling centrifugal machine.

2. Bottles for the same.
3. A chemical washing bottle.
4. Two pipettes, one holding 15cc, and the other graduated to measure 1½cc.
5. A small glass vessel with a lip, for pouring sulphuric acid.

REAGENTS. 1. Sulphuric acid, sp. gr. about 1.83.
2. Amyl alcohol (Fusel oil).
3. Hot water.

METHOD OF OPERATION.

Measure 15 cc of the milk to be tested into each of the bottles and then fill with sulphuric acid to within half an inch of the neck. Grasp each bottle by the neck and whirl between the fingers until all of the curd is dissolved, after which add 1½ cc of amyl alcohol and shake until the contents are well mixed. All of the bottles having been prepared in this way, are then placed in the centrifugal machine and whirled one minute, after which they are filled nearly to the top of the neck with hot water and again whirled for half a minute. The column of fat is then read from the bottom to the true surface and, by reference to the "ready reckoner" card the per cent of fat is obtained. If the fat should become hard in the neck of the bottle, a jet of hot water blown against it for a moment will be sufficient to melt it. The bottles should be washed out with hot water immediately after using, as they become difficult to clean after standing any great length of time. It makes but little difference whether the alcohol is added before or after adding the sulphuric acid.

The following table gives results of tests with the new method, as compared with those secured by the use of the ordinary Beimling and the gravimetric methods.

Number	Beimling	Gravimetric	New Method
1	3.91	3.86	3.83
2	3.22	3.23	3.22
3	2.96	2.99	3.13
4	2.79	2.83	2.79
5	3.22	3.27	3.22
6	2.96	2.87	3.05
7	3.87	3.80	3.87
8	3.52	3.44	3.52
9	3.22	3.35	3.22
10	3.22	3.17	3.17
11	2.92	2.88	2.88
12	3.31	3.33	3.31
13	3.91	3.87	3.87
14	3.17	3.17	3.13
15	3.22	3.14	3.22
16	3.27	3.29	3.22
17	3.17	3.19	3.21
18	3.44	5.29	3.31
Average	3.29	3.28	3.29

Number	New Method	Beimling
1	4.00	4.09
2	4.35	4.44
3	3.91	3.83
4	3.65	3.83
5	4.26	4.26
6	3.74	3.74
7	3.65	3.83
8	4.44	4.26
9	3.74	3.74
10	4.09	4.26
11	4.52	4.70
12	3.65	3.65
13	4.61	4.69
14	3.91	4.09
15	4.17	4.17
16	4.00	4.09
17	3.83	3.91
18	4.61	4.69
19	3.91	3.99
20	3.91	3.91
21	4.35	4.35
22	4.00	4.00
23	3.91	4.00
24	4.35	4.35
25	4.61	4.61
26	4.35	4.48
27	4.17	4.26

Number	New Method	Beimling
28	3.91	4.00
29	4.00	4.00
30	4.44	4.35
31	3.65	3.78
32	4.69	4.00
33	4.00	4.09
34	3.91	3.91
35	3.91	4.00
36	3.83	3.91
37	3.74	3.83
38	3.74	3.74
39	3.48	3.48
40	3.83	3.83
41	4.09	4.00
42	4.44	4.35
43	6.61	6.70
44	5.83	5.83
45	6.35	6.26
46	5.83	5.83
47	6.52	6.52
48	6.35	6.35
Average	4.22	4.35

The principal advantages of the new method over any other which we have used are:

1. A clear and sharply defined fat column which is easily read by either day or lamp light.

2. The accuracy of the results are not vitiated by the charring of the fat column.

3. The contents of the bottles never foam over.

4. It is the most rapid method we have found, six tests being made in duplicate in twenty-two minutes, and one test in duplicate in four minutes.

5. Cheapness, each test costing only about one-fifth of a cent.

Feeding for Milk and Butter.

E. R. LLOYD.

On January 18, 1892, thirty cows from the College herd were put into the Station barn for a continuation of the work of 1890 and 1891 in determining the relative values of different foods for the production of milk and butter. The herd was divided into six lots of five cows each, one cow from each lot being a grade Holstein and the remaining four grade Jerseys. The herd was so divided that, as nearly as possible, the cows in each lot should average the same time from calving. The test was continued five weeks, the first being considered preliminary, and the results for that week are not given. Each cow was given all the hay she would eat, and the average daily rations consumed were:

Lot 1—7.07 pounds Bermuda hay, 10 pounds ensilage, 7.8 pounds raw cotton seed.

Lot 2—4.9 pounds Timothy hay, 9.8 pounds ensilage, 8 pounds raw cotton seed.

Lot 3—7.5 pounds Bermuda hay, 9.9 pounds ensilage, 9.9 pounds steamed cotton seed.

Lot 4—6.5 pounds Timothy hay, 9.9 pounds ensilage, 9.9 pounds steamed cotton seed.

Lot 5—10.2 pounds Bermuda hay, 9.9 pounds ensilage, 8.8 pounds cotton seed meal.

Lot 6.—8.8 pounds Timothy Hay, 9.9 pounds ensilage, 8.8 pounds cotton seed meal.

The Bermuda hay was "choice" from J. C. Rand of Oktibbeha county, and the Timothy was also "choice" from Moon, Jones & Co., Memphis, Tenn. In estimating the cost of feeds, Bermuda hay is valued at $10,00 per ton, Timothy hay at $21,46, cotton seed at $6,00, cotton seed meal at $20,00, and ensilage at $2,00. The ensilage was given in equal quantities to all the lots and was added with the dry feeds to improve the appetite and to keep

the animals in better condition. The steamed seed was cooked with an "Allen Combined Feed Cooker," the increase in weight of the seed by steaming compensating for the extra labor.

In calculating the cost of milk and butter, no account is taken of the expense of milking, feeding, and attending to the cows, the experiment having been conducted to find the comparative values of the different foods, and as the cost of attention to the different lots would have been practically the same, the final results would not have been varied by adding this item.

The milk from each cow was weighed separately and the tests for butter fat were made daily, morning and evening, from the mixed milk from each lot. The testing was done by a new method devised by Mr. L. G. Patterson, one of the Station chemists, and which was tested thoroughly in comparison with the Gravimetric, Babcock, and Beimling methods and found to give equally good results before being adopted for the present work. A full description of the method will be found in part 2 of this bulletin.

The general results were as follows:

		Feed.	Cost of Feed	Morning Milk	Afternoon Milk...	Average Test.....	Butter	Milk.		Butter.	
								Gallons	Cost per Gallon cts	Pounds	Cost per pound cts...
Lot.....	1	Bermuda Hay,									
		Ensilage,		728½		5.35	38.899				
		Raw Cotton Seed...	9.65		492½	6.55	34.217	152.6	6.3	73.116	13.2
Lot.	2	Timothy Hay,									
		Ensilage,		658½		5.21	34 269				
		Raw Cotton Seed ..	11.30		432	6.25	27.029	136.3	8.3	61.298	18.4
Lot.....	3	Bermuda Hay,									
		Ensilage,		1025		5.21	53.446				
		Steamed Cot. Seed	10.79		723	6.48	46.899	218.5	4.9	100.345	10.9
Lot	4	Timothy Hay,									
		Ensilage,		856½		5 19	44 532				
		Steamed Cot. Seed..	15.32		607½	6 56	39.840	183.0	8.4	84.372	18.1
Lot.....	5	Bermuda Hay,									
		Ensilage,		1008½		5.16	51.445				
		Cotton Seed Meal..	20.88		690	6.33	43.825	212.3	9.8	95.270	22.0
Lot	6	Timothy Hay,									
		Ensilage,		1016½		5.15	52.902				
		Cotton Seed Meal..	26.97		689½	6.26	43.087	213.2	12.6	95.989	28.1

The best results from the feeding were obtained from lot 3, fed on Bermuda hay, ensilage, and steamed cotton seed. This

lot gave the largest yield of milk and butter, producing milk at a cost of 4.9 cents per gallon, and butter at 10.9 cents per pound. The average content of butter fat for this lot was slightly lower than was that of lot 1, fed on Bermuda hay, ensilage, and raw cotton seed; and of lot 4, fed on Timothy hay, ensilage, and steamed cotton seed; but the larger quantity of milk produced more than compensated for the deficiency of one ninth of one per cent in butter fat. Lot 4, fed on Timothy hay, ensilage, and steamed cotton seed, (the same grain ration as lot 3) produced milk at a cost of 8.4 cents per gallon and butter at 18.1 cents per pound. In other words, the milk and butter from lot 4 cost about 65 per cent more than did that from lot 3.

The most expensive milk and butter were produced by lot 6, fed on Timothy hay, ensilage and cotton seed meal, the milk from this lot costing 12.6 cents per gallon and butter 28.1 cents per pound.

By comparing the averages of the three lots fed on Bermuda hay with the averages of the three lots fed on Timothy hay, (the grain rations being the same in both cases) it is seen that with Bermuda hay, milk was produced at a cost of 7.08 cents per gallon and butter at a cost of 15.5 cents per pound; while with Timothy hay milk cost 10.06 cents per gallon and butter 22.17 cents per pound.

If the Timothy hay could be purchased at the same price as was the Bermuda, these figures would be materially changed and the cost of the milk and butter would be practically the same, the exact figures being—

Bermuda. Cost of milk 7.08 cents per gallon; butter 15.49 cents per pound.

Timothy. Cost of milk, 7.04 cents per gallon; butter 15.51 cents per pound.

These figures indicate that, ton for ton, the two hays have practically the same milk and butter producing values, and that the one which can be purchased at the less cost per ton is the cheaper food. The results agree very closely with those obtained in 1890 and in 1891, and serve to confirm the conclusions published in Bulletin 15.

It should be observed that the figures given indicate only the relative cost of the milk and butter from each lot, though the real difference in values was much greater than is shown, the quality of the butter from the cows fed on steamed seed being much superior to that of either of the other lots, this being espe-

cially true of the two lots fed on raw and steamed seed. No difference could be observed in the quality of the butter made from the two kinds of hay.

The cows fed with Timothy hay made an aggregate gain of 250 pounds, against a gain of 148 pounds in those fed on Bermuda; and the cows fed with meal made a gain of 258 pounds against one of 124 pounds in those fed with steamed seed, and 16 pounds in those fed with raw seed.

By comparing the averages of the lots fed on steamed seed, raw seed, and on cotton seed meal, (the rations of hay being the same in each case) it is found that with steamed seed, milk was produced at a cost of 6.5 cents per gallon and butter at 14.3 cents per pound; with raw seed, milk was produced at 7.25 cents per gallon and butter at 15.58 cents per pound; and from cotton seed meal, milk was produced at a cost of 11.13 cents per gallon and butter at 25.02 cents per pound.

CONCLUSIONS.

From the work accomplished during the past three years it appears that:

1. Equal weights of Bermuda and of Timothy hays have practically the same values for the production of milk or butter.

2. At the prices at which they can be purchased in Mississippi, Bermuda hay will produce milk or butter at a much less cost than will Timothy hay.

3. The milk and butter from cows fed on steamed cotton seed costs less than that from cows fed on raw cotton seed, and but little more than one-half as much as that from cows fed on cotton seed meal.

4. The butter from steamed seed is superior in quality to that from either raw seed or from cotton seed meal.