UNIVERSITY OF TENNESSEE

Agricultural Experiment Station

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THE CHINCH BUG.

BLISSUS LEUCOPTERUS (*Say*).

Bulletins of this Station will be sent, upon application, free of charge, to any Farmer in the State.

KNOXVILLE, TENNESSEE, U. S. A.

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OF THE UNIVERSITY OF TENNESSEE.

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AGRICULTURAL EXPERIMENT STATION,
KNOXVILLE, TENN.

☞ The Experiment Station building, containing its offices, laboratories and museum, and the plant-house and horticultural department, are located on the University grounds, fifteen minutes walk from the Custom House in Knoxville. The Experiment farm, stables, milk laboratory, etc., are located one mile west of the University, on the Kingston pike. Farmers are cordially invited to visit the buildings and experimental grounds.

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*Died, May 12th, 1895.

THE CHINCH BUG.

CHAS. E. CHAMBLISS.

THE HISTORY OF THE CHINCH BUG IN TENNESSEE.

The presence of this insect within the State was first noticed (so far as known) by Mr. J. W. Ryan, of Almaville, Rutherford county, in 1868. There can be no doubt as to the correctness of Mr. Ryan's identification, for previous to this time, he had often fought the chinch bug in Illinois, and consequently the insect was no stranger to him when found in the wheat field, at harvest time. During that year, very little damage was done, and no complaint was made except from this locality.

It was in 1874, that the corn crop was considerably damaged by this insect in the vicinity of Rives, Obion county. Ever since this date, it has been seen every year in this county as far south as Kenton, attracting general notice in 1885 near Harris, when the wheat was greatly damaged, and again at Kenton, in 1890.

In 1888, this insect appeared again in Rutherford county in large enough numbers to cause some alarm in and near Rocky Fork, Snell, La Vergne and Almaville.

Although outbreaks of the chinch bug have occurred several times within the State, these insects have been more numerous this past season and have devastated a larger area than ever before. Instead of the western part of Rutherford county suffering from the work of this pest as in 1888, the whole county was more or less affected. The work of destruction was not confined alone to this county, for it extended into Wilson county, as far north as Mt. Juliet; into Cannon county, as far east as Bradyville; into Bedford county, as far south as Bell Buckle; into Williamson county, as far west as Thompson's Station, and into Davidson county, as far north and west as White's Creek.

So far as I can obtain information, the insect appeared in Williamson, Cannon, and Bedford counties for the first time in the summer of 1895, while in Wilson county it was noticed near Partlow in 1893, and in Davidson county, near Antioch, in 1891.

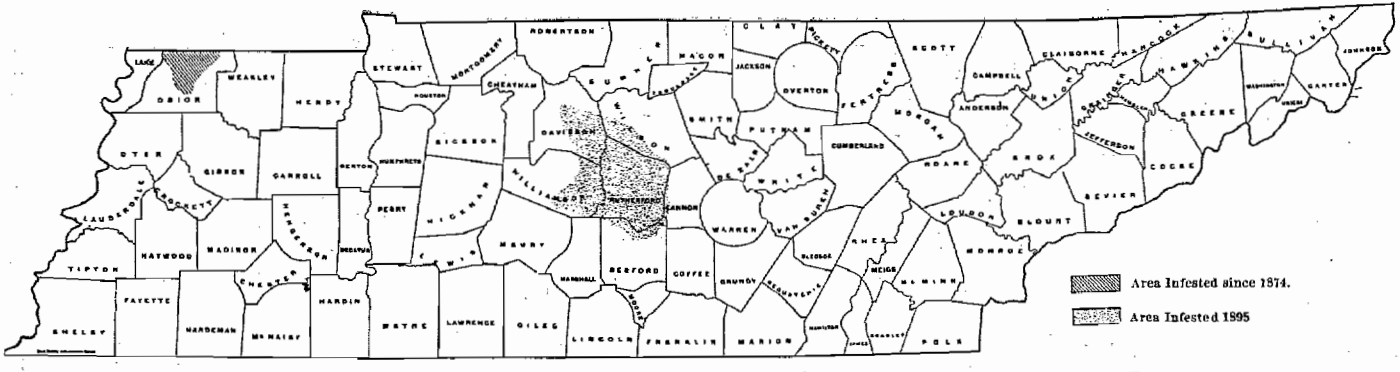
The chinch bug had never been known to be in East Tennessee until September 8, 1895, on which date, I collected four specimens

while sweeping some wild grasses near Knoxville. Since it exists in our midst, we have good reason to fear that it may become as destructive here as elsewhere, for only long and continuous droughts are necessary for its rapid increase, and hence the life-history of the chinch bug should be as deeply interesting to East Tennesseeans as to residents of the other sections of the State.

During the past season, the region between Rocky Fork and Almaville suffered most. On July 1st, between these two places I found the bug so numerous on the corn and sorghum adjoining wheat fields, that the upper and lower surfaces of leaves, and stalks as far up as two feet, were so densely covered, that hardly a green part of that portion of plant could be seen. In many places, as much as one acre would succumb to the attack of this horde of insects in less than a week, after which the fields would look as though they had been destroyed by fire. From reports received, it appears that, in the six counties already mentioned, corn and millet suffered most from the ravages of the pest, and that each of these crops was damaged twice as much as wheat.

It is an established fact that wet weather is extremely disastrous to this pest, while dry weather is favorable to its increase. It will be noticed that in the table given, the amount of rainfall for 1892,-'93 and '94 gets less and less, and that the autumn of 1894 is much drier than the two preceding autumns, and followed by a rather cold winter and late spring, the last month of which is the driest since 1891. This dry May is followed by the driest June on record for Florence Station. (The temperature and rainfall for Florence Station have been recorded ever since 1883.)

The Experiment Station was not notified of the presence of these insects until June 28, 1895, when nearly all the small grains had been harvested. When I reached the field the large majority of the bugs had migrated into the corn and sorghum, and consequently the insect could only be fought with insecticides, the results of which are given under the head of remedies.



MAP SHOWING SECTIONS OF THE STATE WHICH HAVE BEEN INFESTED BY THE CHINCH BUG.

Average Temperature and Rainfall, Compiled from Observations at Florence Station,* Rutherford County. Reported to State Weather Bureau.

YEAR.	MARCH.		APRIL.		MAY.		JUNE.		JULY.		AUGUST.		SEPT.		OCT.		NOV.		Total precipitation from March to November.
	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	
1892	46	4.03	59	8.62	67	4.15	77	3.06	76	4.38	76	2.32	65	2.27	59	.26	45	4.77	33.88
1893	48	2.61	61	3.75	66	10 03	75	4.30	83	1.86	76	2.75	70	4.46	57	2.71	47	1.83	30.44
1894	53	3.94	60	3.42	66	5.13	76	2.34	75	3.01	78	1.93	72	3.10	58	.61	44	2.23	23 49
1895	48	5.26	59	6.12	64	1.34	76	1.97	76	5.02	77	3.13	74	2.19	54	1.78	....	.....	.....

*The temperature and rainfall at Florence Station have been taken, as it is near the centre of the infested region. If unrecorded reports can be relied upon, other localities in the same region have suffered more from a drought than Florence Station.

ITS PAST HISTORY IN THE UNITED STATES.

In his Second Report of the Noxious Insects of New York, Dr. Fitch states that this insect was first noticed as a depredator upon wheat in the interior of North Carolina, about the year 1783. In North Carolina, it was for a long time called the Hessian-bug, as it was supposed by the ignorant classes to have been brought into the State by the German soldiers, who, about that time, marched through North Carolina, as a detachment of the British army. For several years after this, it increased and spread rapidly, causing great alarm throughout Virginia and the Carolinas. In 1809, the destruction of wheat by this insect became so alarming, that the cultivation of this grain was abandoned for two years, in Orange county, N. C. In these same States, great damage was done to corn and wheat in 1839.

It was about 1840, when this insect attracted great attention in the upper Mississippi valley. As it appeared in Illinois at the time the Mormons were establishing themselves at Nauvoo, the bug was called the "Mormon louse," for it was supposed that the Mormons brought it with them.

In Missouri, its first recorded appearance was in 1836; in Iowa, 1847; in Indiana, 1854; in Camden county, Ga., in 1859, where it injured the rice crop, and in Wisconsin in 1855.

The most noted outbreaks of the chinch bug have occurred in the following years: In 1864, Dr. Shimer stated "that three-fourths of the wheat and one-half of the corn crop were destroyed throughout many extensive districts, comprising almost the entire North-west, with an estimated loss of more than $100,000,000 in the currency that then prevailed."

In 1871, the wheat, oat and barley crop were almost destroyed in Illinois, Southern Iowa, parts of Indiana, Nebraska, and Northern Missouri and Kansas. To these crops, Dr. Le Baron estimated the loss to be $10,500,000 for the State of Illinois alone, and the total loss of the year in the North-western States at least $30,000,000, from this one species of insect.

For 1874, Dr. Thomas estimated the loss to the nation of at least $100,000,000, by this small insect, and further stated that "as the species appears to have a maximum of development about every five years, the foregoing estimates render it probable that the annual loss to the nation by its operations averages $20,000,000."

It was not until 1881 that this pest attracted again any considerable notice. During this year, much damage was done in some of the Western States.

In 1887, marked injury was done to crops in Kansas, Indiana, Ohio, Nebraska, Southern Illinois, and parts of Missouri, aggregating a loss

of $60,000,000. For the first time in many years, this insect occurred during this season in immense numbers in portions of Virginia, and North and South Carolina.

In 1894, the destruction to crops by this insect in Illinois, Missouri, Kansas and South-eastern Iowa, nearly reached the highest record point.

BLISSUS LEUCOPTERUS (*Say*).

(*Order*, Hemiptera: *Suborder*, Heteroptera; *Family*, Lygæidæ.)

Lygæus leucopterus *Say:* Heterop.-Hemip. N. A., 1831, p. 14; in Trans. N. Y. St. Agri. Soc. (for 1857), xvii. 1858, p. 774; Ent. of N. A. ed. J. L. LeConte, 1891, i, p. 329.
Rhyparochromus devastator *Le Baron:* in Prairie Farmer, v, 1845, p. 287; id. ix, 1850, pp. 280–1.
Rhyparochromus leucopterus *Harris:* Treat. Ins. New Eng., 1852, pp. 172-3; Ins. Inj. Veg 1862, pp. 197–199, fig. 84.
Micropus leucopterus *Fitch:* in Trans. N. Y. St. Agri. Soc. for 1855, xv, 1856, pp. 509-529; 1st and 2d Rept. Ins. N. Y., 1856, pp. 277-297, pl. 4, figs. 2, 2a.
Blissus leucopterus *Stal:* Enumeratio Hemipt. No 4, 1874, p. 133.

Although this insect was known in North Carolina as far back as 1783, it was as late as 1831 before it received a scientific name. It was described by Mr. Say and referred by him to the genus *Lygæus*, with the specific name of *leucopterus*, meaning white-winged. In 1874, Dr. Uhler and Dr. Stal of Stockholm placed this species in the genus Blissus, where it is now found.

The original description is as follows:

Blackish, hemelytra white with a black spot.

Inhabits Virginia.

Body long, blackish, with numerous hairs; antennæ, rather short hairs; second joint yellowish, longer than the third; ultimate joint rather longer than the second, thickest; thorax tinged with cinereous before, with the basal edge piceous; hemelytra white, with a blackish oval spot on the lateral middle; rostrum and feet honey-yellow; thighs a little dilated.

Length less than three-twentieths of an inch.

THE LIFE HISTORY OF THE CHINCH BUG.

In autumn, when the grasses upon which the chinch bugs feed become too dry to furnish further nourishment, necessity forces them to seek shelter for the winter, during which time they take no food. In selecting a home for the winter, they always avoid damp and wet places, and choose situations which have a good drainage. In such places the bugs will hide under corn shocks, straw-piles, stumps, logs, and in fact all kinds of rubbish which will furnish them a secure retreat from the blasts of winter. If a piece of woodland be near, many will move into it, hiding under the fallen leaves and in the

crevices of the bark. While the weather is cold, they remain torpid, but warm spells arouse them to activity, which often injures their vitality. An extremely cold winter preserves them better than an open one, with repeated thawings and freezings. It is a common opinion that a cold winter destroys our insect enemies, but unfortunately this is not based upon facts.

The chinch bug hibernates only as an adult or winged insect. Upon the advent of spring, they show great activity during the warmer parts of the day, but eat nothing. They do not seem to require food when they first awake from their winter sleep, but as the nights get warmer, they satisfy their appetites by tapping the tender grasses which may be near by. Only a brief time elapses before all take wing and fly in search of food for themselves and offspring. Every field does not attract them, for it must be of a certain kind before they will settle. In seeking a place to establish themselves, they almost always select fields, or portions of a field, well drained; and if these conditions do not exist, poorly cultivated land, or portions of a field that have a poor stand, are almost invariably chosen. Such places furnish them warmth and dryness, which they so dearly love.

Occasionally when the autumn is very warm and dry, mating occurs before entering their winter quarters, but as a general rule this does not take place until spring after they have taken wing. Soon after they have settled in their new home, the sexes mate, after which the female begins to deposit the eggs for the first brood. For this brood, wheat is generally selected as the food plant, and if the soil is dry or easily penetrated, the female deposits her eggs upon the rootlets or stalks beneath the ground; but if wet, the majority of the eggs are doubtless placed on stalks above ground. One female is capable of producing 500 eggs, and the deposition of these requires from two to four weeks, which length of time lessens the chances of an entire brood being destroyed by rain.

THE EGG (Fig. 1, *a. b.*) is elongate oval, with a diameter one-fifth of the length, which is .03 inch. The top is square, near the middle of which there are four round tubercles. When newly laid, it is pale, whitish and translucent, but acquiring with age an amber color, and just before hatching the red parts of the future insect become visible toward the tubercled end. On an average it hatches in two weeks.

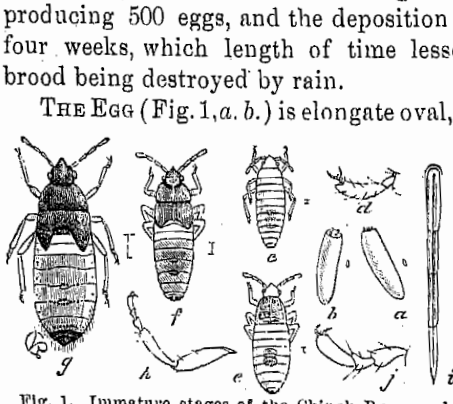


Fig. 1. Immature stages of the Chinch Bug. *a*, *b*, eggs; *c*, newly-hatched larva; *d*, its tarsus; *e*, larva after first molt; *f*, same after second molt; *g*, pupa—the hair lines indicate the natural sizes; *h*, enlarged leg of perfect bug; *j*, tarsus of same, still more enlarged; *i*, rostrum or beak, enlarged.

THE NYMPH is a term applied to all the stages (the larva and pupa) between the egg and full winged or adult state of all insects, with an incomplete metamorphosis. In shape, the newly hatched insect is like the adult, but with two- instead of three-jointed feet, without wings, much smaller and more brilliantly ornamented, (Fig. 1,*c*). A pale yellow color pervades the whole body, except the middle of the three larger abdominal joints which are stained with orange. As the young bug grows, the entire body becomes red, except the first two abdominal joints, which remain yellowish. While the body is changing its color, it is also outgrowing the outer skin, which finally causes the insect to throw off this old coat and take a new one, which act is known as molting. This occurs four times during the life of the insect. After the first molt, the body changes to a bright vermilion color, (Fig. 1, *e.*); after the second, the head and thorax are quite dusky, and the abdomen, duller red, wing pads become apparent, (Fig. 1, *f.*); after the third molt, the pupal stage is reached, revealing a brownish-black head and thorax and larger wing pads of the same color, and a dingy gray abdomen, (Fig. 1, *g.*); after the fourth molt, appears the adult or winged insect which has been already described, (Fig. 2 and 3.)

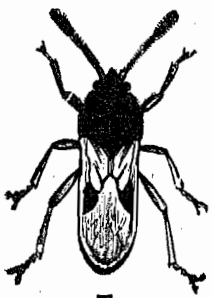


Fig. 2. Perfect Chinch Bug.

The time required for transforming the newly hatched larva into a winged insect varies according to the season. If the season is warm and dry, forty-two to forty-eight days are required; but in cold and wet seasons, the time is much longer.

THE MIGRATION of the vast hordes of these insects from the wheat fields into the adjoining fields of corn, sorghum or millet occurs when the wheat becomes too ripe to furnish them further sustenance. At this time most of the bugs are wingless, and consequently they move out of the ripe or harvested wheat on foot. Even those that have wings do not seem disposed to use them. When thus deprived of food, hunger prompts them to seek elsewhere for it, and by a common impulse they seem to move into the neighboring fields, where only the outer rows are seized first. As their number is now concentrated upon a few plants, one can realize how numerous they have been in the fields just abandoned. The stalk is first attacked, then the whole plant, even to the extremities of the leaves, and often the bugs are so numerous that hardly a green part of the plant can be seen for the first two or three feet above the ground.

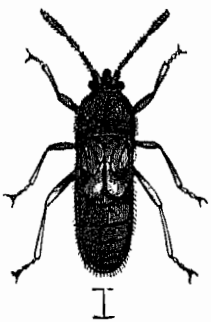


Fig. 3. Short-winged form of Chinch Bug.

Soon after the invasion of the corn field, the adult or winged form

becomes more numerous. Mating soon takes place, and the eggs for the second brood are laid. These are, as a rule, placed behind the old and withered sheaths of the lower corn leaves. During the deposition of the eggs for this brood, the insects scatter throughout the entire field, so that often they are not very noticeable after the outer rows have been destroyed, and hence are supposed to be dead or gone.

BROODS.—From observations in Illinois, Riley made a definite statement in 1866 that the chinch bug was two-brooded in Northern Illinois, and Mr. Howard has since stated that this number of annual generations holds through the entire north-west and as far south as the latitude of St. Louis. There can be no doubt that during the past season there were three broods of this insect in Middle Tennessee; for I took a few eggs from behind the sheaths of the lower leaves of corn, as early as June 29, 1895, and nearly every adult, at this time, was copulating. Furthermore, during the first week of November, most of the individuals were in the pupal stage, while a few were winged, which form lives through the winter.

FOOD-PLANTS.—The chinch bug feeds upon all grains and grasses, so far as known, but never on any other plant. Wheat, barley and Indian corn seem to suffer most from the ravages of this pest.

The work of the chinch bug during the past season upon the following grasses* was marked. On Timothy (Phleum pratense Linn.) which was very abundant in the bottom lands, I noticed that nearly every blade supported these insects, and from the number that was on the grass, it appeared that they were very fond of it. In several millet fields, Paspalum ciliatifolium Michx. and Green Foxtail (Setaria viridis Beauv.?) furnished food for many bugs, and on the roots of the first, where the soil was loose and dry, they were exceedingly numerous.

Hardly a specimen of the Crab-grass (Panicum sanguinale Linn.), especially if in the woods, could be found without chinch bugs on it, and I was told by a farmer that he had seen a strip of Johnson-grass (Andropogon Sorghum Halepense Hackel), which was between a wheat and corn field, completely "sucked down" by this insect.

DISTRIBUTION.—East of the Rocky Mountains, the chinch bug seems to be indigenous North and South, feeding naturally upon various species of wild grasses, and becoming multiplied wherever the cultivation of wheat has reached its original haunts (Howard). It is also in California, but outside of the United States, it has only been collected in Cuba and Canada.

*Identified by Samuel M. Bain, the Station Botanist.

NATURAL ENEMIES AND DISEASES.

There are many insects that occasionally prey upon the chinch bug, although protected more or less by an offensive odor. Though the list of its insect enemies is a rather large one, very few of these predaceous species show any decided taste for such an unsavory morsel, and consequently the work of destruction is not marked enough to make any appreciable impression upon the hordes of these insects that reduce the yield of our crops.

Fig. 4. The Spotted Lady-bird.

The contents of the stomachs of the following beetles were examined by Prof. Forbes, with the following results:

Hippodamia glacialis *Fabr.* In the four specimens of this species dissected, 8 per cent. of the food was found to be chinch bugs, 18 per cent. plant-lice and the rest vegetation.

Fig. 5. The Plain Lady-bird.

The Convergent Lady-bird (Hippodamia convergens *Guer.*). In the five specimens examined, one-third of the food was found to consist of equal parts of chinch bugs and plant-lice.

The Ground Beetle (Agonoderus pallipes *Fabr.*) By dissection, one-fifth of the total food was found to be chinch bugs. (Fig. 8.)

The Spotted Lady-bird (Megilla maculata *DeG.*) preys upon the chinch bug as well as upon the eggs of the Colorado potato beetle and those of certain bark-lice (Walsh). (Fig. 4.)

The Plain Lady-bird (Coccinella sanguinea *Linn*) eats the chinch bug (Thomas). (Fig. 5.)

The Insidious Flower bug (Triphleps insidiosus *Say*) feeds upon the chinch bug (Riley). (Fig. 6.)

The Many-banded Robber (Milyas cinctus *Fabr.*) has been observed by Riley in the act of preying upon the chinch bug. (Fig. 7.)

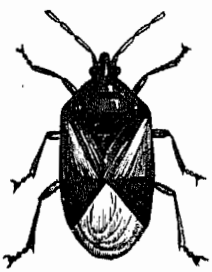


Fig. 6. The Insidious Flower Bug.

The Weeping Lace-winged Fly (Chrysopa plorabunda *Fitch*) is very active in destroying the chinch bug (Shimer).

Of the above insects, I noticed that *Megilla maculata* and *Hippodamia convergens* were very numerous, but so far as my observations extended, they seem to prefer the fungus which was growing on most of the stalks, instead of the chinch bugs. In several places, the eggs of a Lace-winged Fly were found, but no larvæ.

To this enumeration of predaceous insects, may be added the vertebrate enemies of the pest.

Of the birds, the following have been found to eat the bug occasionally:—the Prairie Chicken, the Red-winged Black-bird, the Cat-bird, the Brown Thrush, the House-wren, the Meadow Lark, and last, but the most efficient destroyer, the common Quail or Bob-white.

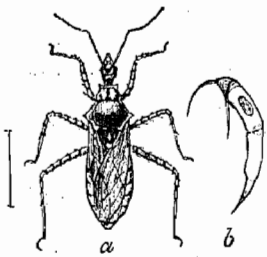


Fig. 7. The Many-banded Robber.

Many years ago, Dr. Riley published the fact that the common quail was very effective in reducing the number of chinch bugs, during the winter. This has since been confirmed by many observers. Dr. Riley says that "in the winter time, when hard pushed for food, they must devour enormous numbers of the little pests which winter in just such situations as are frequented by the quail, and this bird should be protected from the gun of the sportsman in every State, where the chinch bug is known to run riot."

The stomach of the common frog has also revealed the fact that many of these bugs are destroyed by this vertebrate.

Beside the enemies already mentioned, the chinch bug is subject to diseases, which, when the right conditions prevail, are more effective in destroying them than would be the united attack of all its insect enemies.

The alimentary canal is often infested with a bacterium (*Micrococcus insectorum*) which increases the size of the abdomen and finally overpowers the insect. As this disease is not very contagious, it does not promise to be of value in fighting this pest.

It was in 1882 that Prof. Forbes discovered the green muscardine disease of the chinch bug, which is due to parasitism by a fungus (*Entomophthora aphidis*). From observation and experiment, he has concluded that it is not probable that it can be made to serve any practical purpose.

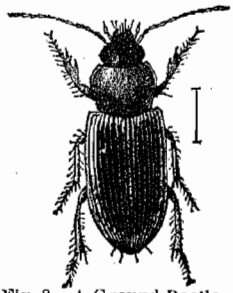


Fig. 8. A Ground Beetle.

Of all the diseases that affect the chinch bug, the White Fungus (*Sporotrichum globuliferum*) is the only one that can be used with any degree of success, and for it to be effective there must be considerable moisture in the atmosphere. When this condition exists, the disease spreads rapidly, killing thousands of the bugs in a short time, being "more fatal to them than the plague of Asiatic cholera ever was to man, more fatal than any recorded disease among men or animals since time began." The old bugs are the first to succumb, but should a rainy season begin, which also affects the vitality of the bug, all

stages of growth of the insect are easily overpowered by the disease. If we could control the conditions which make the spread of the disease possible, we would need no other means for fighting this dreaded pest.

There are other diseases of the chinch bug which are now being studied with the hope that the results will be more practicable than the above, for with our present knowledge of these diseases, we cannot place too much confidence in them, as we have no control over the conditions that are necessary for their spread in the infested fields.

THE REMEDIAL AND PREVENTIVE MEASURES.

As the predaceous insects which prey upon the chinch bug make so small an impression upon their vast armies which sap our corn and other cereals, it becomes evident that to fight them successfully, all our efforts to destroy them must be based entirely upon a knowledge of their habits.

Having learned that they seek shelter from the winter's blast under all kinds of rubbish, why not, in autumn, clean out the fence corners, and remove all the trash within and around the fields? By doing this the number of their hiding places is lessened, and when the work is done thoroughly, the chances of a successful hibernation become fewer. From this fact alone it appears that in *clean cultivation* the first move has been made in reducing their number.

Recognizing the helplessness of the insect during cold weather, the importance of winter work cannot be too much emphasized. For a direct winter remedy nothing can be better than the burning of the trash that shelters this enemy. An effort should be made to find out where the bugs are congregating in the largest numbers for hibernation, and to that place should be carried the fire-brand. If you live in a timber section the fallen leaves may be burned as well as the rubbish in your fields. When well done, the effectiveness of this measure cannot be questioned, for at this time their number is reduced to a minimum, and for every female destroyed, which sex is largely in excess at this season, the spring brood is reduced at least four hundred. To assist in this cremation, traps may be used in the form of shocks of corn stalks. If these be placed at intervals throughout the field, the bugs will be attracted to them, for they always take the shelter which is nearest at hand. These should be placed during early autumn and burned early in December. There may be some objection to the burning of the corn stalks for the reason that it is not the way to enrich the soil, but may it not be asked if it is not better to lose the manure contained in the corn stalks than to have your crop destroyed by insects?

After the harvesting of wheat, the bugs remain in the stubble for several days. This gives another opportunity to deal a blow. After thrashing, the straw should be scattered over the stubble and burned, which beyond a doubt will destroy many.

Again, fire can be used to a good advantage. When the attack seems to be confined to a definite portion of the field, it may pay to overlay it with straw and burn, if the area is not too large.

When a wheat-field is full of chinch bugs, nothing but a long-continued drenching rain can save it. It was this fact, which led Prof. Riley, in his seventh report on the insects of Missouri, to recommend *irrigation*. He states, that wherever it can be practiced "it is the only really available (and) practicable remedy, after the bugs have commenced multiplying in the spring." He further says, "that I believe that it is an effectual antidote against this pest, and that by overflowing the grain-field for a couple of days, or by saturating the ground for as many more in the month of May, we may effectually prevent its subsequent injuries."

Since the bugs like warmth and dryness, they will seek, in the fields, the plants of small and of irregular growth, which is indicative of poor soil. It is a common observation, that the greatest damage is done to plants on the poorest soil, while often those on rich soil escape attack. This fact is suggestive of what? Without much philosophy, we conclude that fertilization of the soil is needed to give the crop the necessary strength to ward off or stand the attack. By experiments with fertilizers, Prof. Forbes has determined that by dressing the soil with a combination of ammonia and phosphates, the tiller will always be rewarded with a reasonable yield, so far as the chinch bug is concerned.

From what has been said in regard to the food-plants of this insect, it follows that by a *rotation of crops*, a better chance is offered to prevent its rapid increase. The same will apply to all injurious insects, for if one plant is allowed to occupy the same locality for a succession of years, the result will be a proportional increase of its insect enemies. Such facts are too evident to need further comment.

In the majority of cases it is harvest time before the presence or work of this insect attracts attention, and before this time of the year, it very seldom causes general alarm. Since the bugs invade the fields of corn, sorghum and millet, on foot, several preventive measures can be resorted to, which will either destroy them or retard their movements. These fields can be protected by digging a ditch or plowing a furrow around the infested field. A furrow is more easily made than a ditch, and if properly attended to will serve equally as well. This furrow should be made as deep as a plow can make it, and the sides and bot-

tom kept very dusty, which can easily be done by dragging a heavy log or brush occasionally through it. If any defects occur in the sides of the furrow, the spade should be used to correct them. In their eagerness to reach fresh food, the bugs will attempt to cross this furrow, but their efforts will be of no avail for the dusty sides will never permit them to climb out It will only take a short time for a large mass of them to accumulate at the bottom of the furrow, at which time they can be covered with straw and burned.

Tarred boards have also been used around infested fields for barriers. The plan is to set boards of six inches in width upon edge, being careful to cover the lower edge with dirt so as to prevent the bugs from crawling under them. The upper edge is spread with fresh tar which will prevent the bugs from crossing. At intervals, on the outside of this barrier holes are dug, into which the advancing armies collect. Thousands and thousands of them can be killed by kerosene or fire while in these pits. This method, although a good preventive, will never come into general use, as it is too expensive; but if ditching would only be generally and conscientiously used, there would be no need to apply other remedies to save the corn, so long as the weather remained dry.

If these preventives fail, owing to neglect or to conditions over which there is no control, insecticides can be used with good results, while the insects are on the outer rows. For the intelligent application of insecticides, a knowledge of the anatomy of their mouth-parts is needed.

Upon an examination of the chinch bug there will be found on the under side of its body, a jointed, honey-yellow tube (Fig. 1, *i.*) extending from its head to the middle of its body. This organ is called the rostrum or beak, and by means of it the bug pierces the tissues of the plant and sucks its food. Since its food is the sap of the plant, insecticides that kill by contact must be used, for as the hard parts of the plant are not used for food, no external coating or poisons will be effective.

Of the small list of insecticides that have been used, kerosene emulsion appears to be the best. In using the emulsion for the chinch bug last summer, I prepared it in the following manner: One-half a pound of whale oil soap was finely divided by means of a knife and dissolved in one gallon of boiling water. To this solution, while hot, was added two gallons of kerosene and forcibly churned or agitated until it was formed into a creamy mass, which usually took ten minutes of steady work.

Most of the spraying with different percentages of the emulsion was applied to corn which had been replanted, and averaged in height about eight inches. Of all the strengths which were tried, I would

recommend the use of emulsion diluted fifteen times, for it will not injure the youngest corn and is sure death to every bug that it touches. The emulsion will not always act at once, for I often noticed that the bug would crawl out of a wet place on a leaf and go several inches before showing any signs of being affected.

The best time to make this application is when the corn stalks and leaves are black with the bugs. Direct the spray where they are the thickest, and allow some of it to run down between the leaf and stalk, so that the bugs within the "boot" may be reached also. Many will be knocked to the ground and seek shelter beneath the clods before receiving enough of the emulsion to kill them, but these can be gotten at another time. To do this work thoroughly it will be necessary to repeat the spraying at least twice in succession, and always during the hottest part of the day when all the bugs are out. To be thorough and at the same time economical in this work, a spraying apparatus is necessary, but if you are without this outfit, you may find a watering can or even a straw broom a fair substitute.

In my experiments with kerosene and water mechanically mixed, I found that by using one part kerosene and fourteen parts of water that bugs could be killed without injury to the plants. Other percentages were tried, but the result of this one was more satisfactory. Though cheaper and just as effective as kerosene emulsion, it can never be generally used on account of the difficulty of keeping water and kerosene mixed at the right proportions. With the knapsack sprayer, with the kerosene attachment, it can be practicably used in small fields, but never in large ones.

Beside dealing death to the chinch bug by rains, nature has subjected it to an epidemic disease, far more dreadful in its work of annihilation than floods themselves. Although this disease has often arisen spontaneously and swept innumerable armies of this insect from our midst, can we ever expect to make it of practical use? For the past ten years much study has been given to the disease, but even at this day it can not be recognized as a true remedy, for we can only propagate the disease, while we must wait for climatic conditions to spread it and make it effective.

Prof. Forbes last year, after seven years' study of this disease, concluded "that infection with the fungus of the white muscardine (which is the name of the disease) of a chinch bug is an uncertain measure, largely dependent for its practical value upon conditions beyond the influence of the experimenter, and whose occurrence or prevalence it is impossible for him to foresee. It appears on the other hand to be so powerful an agency for the destruction of the chinch bug *en masse* when the weather favors its development and spread, and

can be made by proper organization so inexpensive to the individual and to the State, that it is well worthy of the most thorough-going scientific study and practical field experimentation."

How different does this sound from the sensational articles published in the newspapers during the past summer. Most of those who have read these articles, have relied too much upon this disease for the salvation of their crops, and have thrown aside remedies dependent upon the habits of the insect, which in themselves are sufficient, if conscientiously and thoroughly applied.

The attempt to spread the disease last summer in Rutherford county was not successful. On July 10th, two infection boxes were prepared with diseased bugs, which had been received from several Experiment Stations. To propagate the disease, a tight, shallow box was used, in which was placed a layer of dirt half an inch deep. Care was taken to remove from this all leaves or other rubbish, and after moistening it, a layer of green corn leaves were spread upon it. The diseased bugs were scattered over the leaves and with them were shut up a quantity of live bugs, which had been taken from the field. To retain the moisture required for the full development of the fungus, the box was placed in a cellar, and its sides kept damp by occasionally throwing water upon them.

The box was opened every day, and when needed a fresh supply of food was put in for the live bugs. Several days passed before any of the bugs were affected. During this time, many of the nymphs had matured, and often adults would be seen copulating. On July 18th, when the boxes were left to the care of Y. H. Neal and J. A. Ewing, with whom I had been staying, only eighteen bugs had taken the disease. In one week from this date, I learned by letter that all the growths of the fungus had disappeared. It is probable that the fungus was destroyed by some fungus-eating insect, which may have been brought in with the food.

Since the infection boxes were not working as well as I had anticipated, it was very gratifying to discover, while passing through a wet place in a corn-field, that the disease was present without being introduced, but upon a further search, I found that the disease was only in the wettest places, and even in these it was not at all active.

In conclusion, it might be said that for a complete suppression of this dreadful enemy in any community, concerted action in the application of these remedies and preventions is extremely important and necessary; for "in union there is strength."

The figures of the insects were furnished by the Division of Entomology.