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The Chinch Bug.

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The Chinch Bug

Blissus leucopterus, Say.

BY J. M. STEDMAN,

Professor of Entomology in the University of Missouri and Entomologist of the
Experiment Station.

INTRODUCTION.

The chinch bug is perhaps the most destructive insect affecting the wheat and corn plant, although the Hessian fly in some years is a close second. While the Hessian fly is confined in its ravages almost entirely to the wheat plant, the chinch bug is broader in its selection of food, and infests nearly all the members of the grass family. This includes, of course, the wheat and other grains, and the corn, et al. While it will feed when forced to, on account of the scarcity of other varieties, upon practically all members of the grass family, yet it has its preferences, and seems to prefer, other things being equal, such cultivated grasses as Hungarian grass, *Panicum crus-galli*, millet, *Setaria glauca*, blue grass, wheat, corn, sorghum, broom corn, Bermuda grass and crab grass. It will thus be seen that the insect will live and multiply upon various grasses in regions where there is very little or no wheat or corn. In the State of Missouri, the insect does its vast amount of damage by attacking the wheat and the corn plants.

DISTRIBUTION.

The distribution of the chinch bug in North America is confined very largely to that portion east of the Rocky Mountain region, extending from the Great Lakes to the Gulf of Mexico. The insect is found west of the Rocky Mountains in only isolated places. It should not be understood, however, that the chinch bug does an unusual amount of damage throughout this entire area. As a matter of fact, its region of greatest

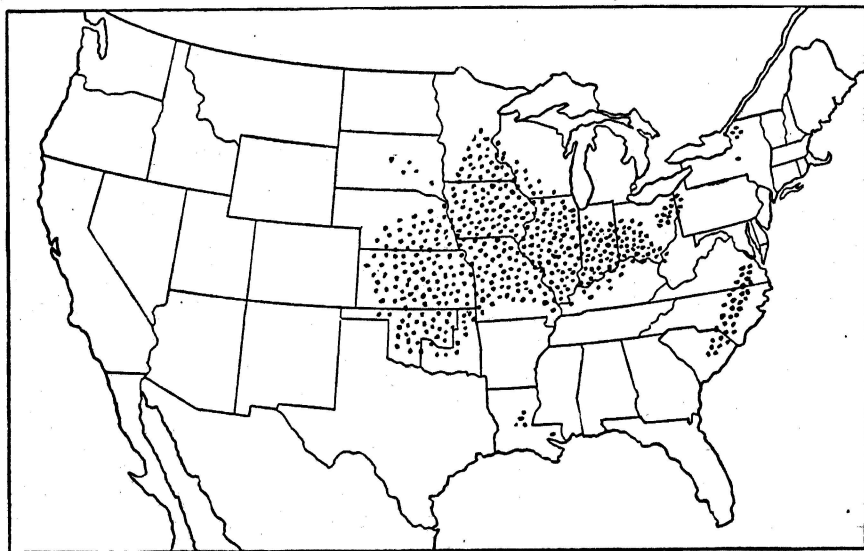


FIG. 1.—Map showing areas in the United States over which the Chinch Bug occurs in most destructive numbers. (From Webster, U. S. Dept. Agric.)

destructiveness is confined to the following states: Ohio, Indiana, Illinois, Minnesota, Iowa, Missouri, Nebraska, Kansas, Oklahoma, Indian Territory, Virginia, North Carolina and South Carolina. Of these twelve states, Ohio, Indiana, Illinois, Iowa, Missouri, Kansas, Nebraska, Minnesota and Indian Territory are by far the greatest

sufferers. A glance at the map of the United States, shown in figure 1, will give you an excellent idea of the area of greatest destructiveness. In the states just mentioned we expect a great annual loss from the ravages of the chinch bug; but like many other injurious insects, the chinch bugs have their ups and downs, and will, as a rule, increase in number, and destructiveness for two or three years before they reach their highest ambitions in this direction, and then they will suddenly drop down to comparatively normal numbers again, and then gradually increase until the height is again attained. They behave very much like spasmodic waves passing over the country.

While the chinch bug has been with us for a great many years, in all too numerous quantities every year, yet in some years, as for instance 1871, the chinch bugs have been unusually numerous and destructive. It was carefully computed by Dr. LeBaron, then State entomologist of Illinois, that the loss in the single year 1871, in only seven states, by the ravages of the chinch bug was \$30,000,000. Those seven states were Iowa, Missouri, Illinois, Kansas, Nebraska, Wisconsin and Indiana. In the year 1874 the chinch bug was again unusually destructive, and in Missouri alone, Dr. C. V. Riley, then State Entomologist of Missouri, computed the loss in this one State by the ravages of this one insect during that single year at \$19,000,000, and stated that for the seven states I have above mentioned the loss for that one year might safely be estimated at \$60,000,000. The loss in the United States for that one year has been estimated at upwards of \$100,000,000. While these estimates are undoubtedly correct, they are enormous, and cover the ravages of but this single insect during one single season. If we take into account the aggregate losses from year to year, one could hardly realize that insects could cause so much damage.

THE DIFFERENT STAGES OF THE CHINCH BUG.

The chinch bug is so well known to most farmers in Missouri that it hardly seems necessary to give any detailed description of it, although the false chinch bug is very frequently mistaken for it. A short description of the different stages of the insect, however, may not be out of place, since the insects differ in their coloring to such an extent between the young and adult stages.

The *eggs* of the chinch bug are very small, and are deposited in masses, each female depositing upwards of five hundred eggs. The eggs, however, are not all deposited in one mass, but may be scattered in several masses; and are placed, as a rule, just under the surface of the ground near or upon the roots or the base of the stems of the grass or the wheat plant, as the case may be. The eggs, while large for an insect the size of the chinch bug, are really very small, measuring only three one-hundredths of an inch in length. See figure 2, *a, b*, which represents two eggs greatly enlarged. When in masses, such eggs appear of a whitish translucent color when first deposited, but later become amber colored, and just before they are ready to hatch, have a decided reddish hue, due to the fact that the young insect shows through the egg envelope.

While most farmers have not observed the eggs of the chinch bug, it is really a very simple matter. If they will pull up clumps or bunches of grass and carefully pull the dirt away from the roots, they will find the little masses of eggs tucked away just under the little clumps of dirt about the base of the plant. Occasionally the eggs are deposited on the stem or between the stem and leaf, above the ground, or between the earth and stem of the plant, rarely on the leaves or further up the plant. The females take from two to four weeks

to deposit their eggs. The eggs hatch in about two weeks, but vary considerably according to the weather. In some instances they may hatch in ten days, and in other cases they may take three weeks. From the time the egg hatches until the adult stage is reached, requires about forty days. Hence you can readily see that from the time the first eggs are deposited until the first adults of this brood appear, would require practically two months.

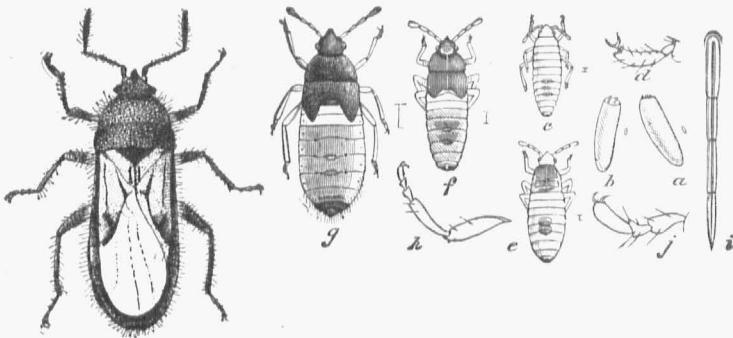


FIG. 2.—Chinch Bug, *Blissus leucopterus*, showing different stages in its development: *a*, *b*, eggs; *c*, newly hatched bug; *d*, its tarsus; *e*, bug after first molt; *f*, same after second molt; *g*, same after third molt; at the left an adult which is the result of the fourth molt, much more magnified; *h*, enlarged leg of adult bug; *i*, proboscis or beak enlarged; *j*, tarsus of same still more enlarged. The lines at the sides of each bug represent its natural size. (From Webster and Riley, U. S. Dept. Agric.)

The *young* chinch bugs when they are first hatched look very little like the adult. They are very small, of a pale yellow color, and with an orange spot on the back of three abdominal segments. See figure 2, *c*. In form these newly hatched bugs are not unlike the adult, but of course, they have no wings whatever. As soon as hatched, they lose no time in seeking a place in which to insert their beaks through the tissues of the plant and suck the sap. After a time they have grown in size

so that their skin becomes too small for them; it then splits open along the back and the creature crawls out, leaving its first skin behind. This is known as the first molt. The insect now appears quite decidedly red, or vermilion, with a pale band across the middle of the body. See figure 2, *e*. After feeding for sometime, the larva again becomes too large for its old coat, and it again splits open along the back and the creature crawls out, leaving its cast skin behind a second time. The insect now has a dusky head and thorax, while the abdomen is of a duller red, with the pale band still distinct. See figure 2, *f*. The future wing pads now become apparent. After feeding and growing for a time, this young chinch bug again sheds its skin. This is the third molt; and this stage of the young bug, which is its fourth stage since leaving the egg, is sometimes spoken of as the pupa stage, since it is next to the adult stage. But in reality, there is no true pupa in this case, because these insects develop by means of an incomplete metamorphosis, and, therefore, these younger stages should all be known as nymphs. See figure 2, *g*. This so-called pupa has a brownish black head and thorax, and the little wing pads that made their appearance in the previous stage are now larger. The abdomen is dingy gray in color with a dark horny spot at the tip. When this insect has reached its proper size, the skin again splits open along its back, and the adult insect comes forth. See figure 2, bug at left.

This *adult* insect has, as a rule, well developed wings extending practically the length of the body, but in some instances the wings seem to be aborted, so that they are not fit for use as organs of flight. By observing a great many adult chinch bugs, one can find various stages, from the adults with very short and useless wings to the adults with long, normal wings, that are of service as organs of flight. The

adults are about three-twentieths of an inch in length, and the body is of a black color with a very fine grayish down. This down can be readily seen under a magnifying glass, but is not visible to the ordinary naked eye. The wings and the wing covers are white, and the wing covers have two irregular black lines and a black spot near the margin. By referring to figure 2, one can obtain a fairly good idea of the general shape and comparative size of the different stages of chinch bugs, from the time they hatch, up through the various stages that I have just described to the adult bug. While the figures show simply the comparative or relative size and the general markings, they do not show the color, which differs so greatly between the adult and the younger stages. Figure 2, bug at left, shows an adult with normal wings, while figure 3, shows three adults with the aborted wings of different lengths, the one to the left showing an adult with very small aborted wings, and the one to the right showing an adult with wings nearly the normal size. Of course all of these figures show the insects greatly enlarged.

HOW AND WHERE THE CHINCH BUGS SPEND THE WINTER.

Chinch bugs always hibernate in the adult condition during the winter. While there are possibly no exceptions to this rule, at least in Missouri, yet it is a fact that by the time the chinch bugs are forced to seek winter quarters, some of them are not quite full grown or adult insects. It appears that those chinch bugs that seek winter quarters before they have reached the adult condition fail for some reason to live through the winter. While this may not lessen the number of chinch bugs to any appreciable extent, it nevertheless is a fortunate circumstance. Late in the fall, when the proper food plants have become more or less dried and cooler weather is approach-

ing, the chinch bugs begin to migrate and scatter, leaving the plants or the fields in which they have been feeding, and crawl about or fly, as the case may be, in search of suitable places in which to pass the winter. This migration usually occurs in Missouri at the time most people call "Indian Summer." The great bulk of chinch bugs have by this time reached the adult condition, and have fully developed wings by means of which they can fly from place to place and scatter about the neighborhood. But it is a very common sight to see those chinch bugs that are perfectly able to fly crawling about, occasionally in large numbers, even in the villages, showing that they have come from the neighboring country, probably by flight. Very frequently they occur in villages at this time of year in such immense numbers as to attract a great deal of attention from the village people, who do not understand the invasion or the name of the insect. Chinch bugs are very apt to leave in great numbers the fields that they have infested during the summer, especially if these fields do not contain a sufficient amount of grass and weeds or shocks of corn, and seek such places as the edge of timber, Osage orange hedges, wind breaks, places where there are plenty of rubbish as along fences, among stone piles or wood piles, hay and straw stacks, and places where there are great masses of rank growth of grass and weeds, especially in the corners of rail fences. The insects crawl under such rubbish, especially under leaves and under matted grass, and will collect in these places in vast numbers. They seek especially the above places that are on high, well drained ground, and seem to prefer sandy or rocky soil to mucky. They shun to a great extent the low places that are liable to be flooded or become excessively damp.

During the winter, these insects remain in a dormant condition in these sheltered, protected and more or less dry

places, and may be readily found during the winter in great numbers by the ordinary farmer, if he will take the trouble to turn over the rubbish near the ground in the places I have mentioned. These insects, however, will become more or less active and sometimes crawl about during the warm days that occur at frequent intervals during our winters here in Missouri. No amount of cold seems to affect the insects whatever, at least 30 degrees below zero has no terror for them, that temperature having been reached in Missouri. In some of the northern states they have been known to withstand 40

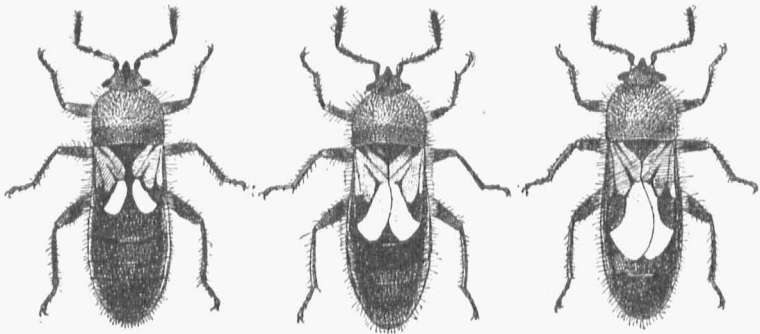


FIG. 3.—Chinch Bug, *Blissus leucopterus*. Adults of short-winged form—much enlarged. (From Webster, U. S. Dept. Agric.)

degrees below zero without any apparent inconvenience. They seem to stand continuous cold weather much better than they can the rapid changes in temperature, from extreme cold to comparative warm spring like weather and then suddenly turning cold again, as usually happens during our Missouri winters. Those immature chinch bugs that go into winter quarters probably perish from the alternate cold and warm weather as well as from dampness. It appears that the immature insects especially cannot endure any great amount of moisture. They seem to have an instinct that teaches them to seek dry places, and the shocks of corn that are so common

in this State, afford the very best places for these insects to collect in the fall and hibernate during the winter. It is no uncommon thing to see thousands of these chinch bugs under a single shock.

THE LIFE HISTORY OF THE CHINCH BUG.

In the spring, as soon as settled warm weather appears and the grass begins to grow, the adult chinch bugs that have passed the winter come forth from their hiding places and fly about in great numbers in search of suitable food. In some springs the insects at this time are so numerous that they attract a great deal of attention from people in the towns by alighting upon them, sometimes by the dozens, especially is this the case if they chance to drive out into the country a little ways. It appears that, in Missouri at least, this is the great migrating season, a season in which the chinch bugs seem to scatter over vast areas and cover greater distances than is the case with the fall migration just previous to their seeking winter quarters. Of course a great many of these chinch bugs do a great deal of crawling instead of flying, but it has been my observation that the vast majority of chinch bugs coming out in the spring from their winter quarters fly instead of crawl; while the migration in the fall is to a very large extent confined to crawling instead of flying. After the insects have found suitable fields or suitable plants for their food, they alight and crawl about, inserting their beaks through the tissues of the plant and sucking its sap. Chinch bugs in seeking their proper food plants in the spring alight in immense numbers in our wheat fields. If the wheat field happens to be near a wood, or Osage orange hedge fence, or a wind break, or a place where there is plenty of shelter in which vast numbers have hibernated during the winter, then,

in this case, the chinch bugs are very apt to come out from their winter quarters and crawl in vast numbers to the wheat field. In such instances they are usually found collected or massed together on the plants nearest the hibernating quarters, and their presence will soon be detected by the effect that they have upon the plants. It seems that chinch bugs, when they insert their little beaks into the plant, involuntarily inject a little poison, which poison causes an increased flow of sap to that place, and has more to do with the injury to the plant than the amount of sap that the insect actually extracts. A wheat field attacked in the way just mentioned will appear bleached in the area or strip attacked. If left undisturbed, the chinch bugs will gradually spread from plant to plant, so that the area of infestation will increase and move onward, gradually covering the entire field.

While a great many chinch bugs mate in the fall, the vast majority of them mate in the spring soon after leaving their winter quarters, and presently the females begin to deposit their eggs in the wheat fields or other places, usually just below the surface of the ground under little clods of earth about the roots and base of the plants. In about sixteen days these eggs will begin to hatch, and presently the agriculturist will detect the little yellow or reddish bugs in his wheat. In about six weeks these insects will have reached the adult condition, and his wheat field will be literally overrun with chinch bugs. Meantime, the young bugs have been drawing their nourishment from the wheat plants by sucking the sap, and have done more or less damage according to the number of bugs in a field. Since each female lays upwards of five hundred eggs, one can form an idea of the extent of the multiplication of these insects since leaving their winter quarters. As the females take about three weeks to deposit their eggs,

and as these insects hatch at different periods according to the weather, we find that new adult chinch bugs are appearing for three weeks or more after the first ones have appeared. At about this time the chinch bugs have become dangerously numerous in the wheat field, the great bulk of them have become adults, and have done a great deal of damage, and the wheat plant has become ripened and no longer fit for their food. The chinch bugs in such a field now take it into their little heads to seek green pastures, and they usually do so all at once, and migrate in a body leaving the old field. In this migrating army we find the adults with fully developed wings and perfectly capable of flight, and the young in various stages of development. It is a curious fact that in this migrating army of chinch bugs, the adults with fully developed wings rarely attempt to fly, but crawl along with the mass the same as those immature bugs that cannot fly. In fact, it seems difficult to induce the adult chinch bugs to fly at this time, and it is curious to watch such a migrating army when they attempt to cross dusty roads or plowed fields. The adult bugs will struggle along with the wingless immature ones and not attempt to fly, when by so doing they could readily span the difficult places.

At this season the chinch bugs are very sure to migrate in the above described way from the wheat field to the corn field, and when they reach the corn field, they are tired and hungry, and undoubtedly thirsty, for they attack the first corn plant and begin to insert their beaks and immediately suck the sap from the plant. At this time the bugs will cover the first few rows of corn to such an extent as to render it black with them, and especially is this the case with the lower part of the corn plant. The bugs will remain here on the first few rows of corn for a short time, and then they will grad-

ually disperse throughout the corn field. The adults pair and lay their eggs for another brood, and this second brood of chinch bugs, in addition to the first brood which has now migrated, infest the corn and causes the vast amount of mischief so well known to the farmers of Missouri.

By the time the bulk of this second brood of chinch bugs in the corn have reached the adult condition, the time has approached for them to seek winter quarters, and the fall migration begins to occur. If the proper winter quarters are near at hand, the bulk of the insects will migrate on foot to those places; otherwise, the winged forms will now readily take to flight and travel considerable distance in search of suitable places in which to pass the winter. If the corn is cut at this time and stacked in shocks about the field, the farmer has given these chinch bugs the best kind of winter quarters, and they will readily seek them and hibernate in vast numbers in these situations. It will be seen then that chinch bugs have three migrating periods. A period in the fall during which they migrate by crawling and by flight in search of winter quarters; a migrating period in the spring when the insects come out from their winter's hibernation and fly about in search of the proper food plants; and a mid-summer migration in which the chinch bugs crawl in a mass in search of a fresh supply of food and rarely take to flight. There are, in Missouri at least, only two broods of the chinch bug each year, but these two broods always occur.

NATURAL ENEMIES.

Unfortunately for the agriculturalist at least, the chinch bug has few natural enemies; especially is this the case with its insect enemies. Most insects are held in check by other insects that are either predaceous, (that is devour them,) or

parasitic upon them. But the chinch bug seems to be largely immune from the attack of either the predaceous or the parasitic insects; at least they are not in sufficient quantities to do us any particular good in that direction, and it therefore seems hopeless for the agriculturist to ever expect that the chinch bug will be held in check by other insects. One of the predaceous insects most destructive to the chinch bug is shown in figure 4. There are some birds, however, that feed upon chinch bugs, but, unfortunately, the birds are so scarce now-a-days that we can hope for very little help from this source. The quail is perhaps the most beneficial bird that we have along these lines, for they devour great numbers of chinch bugs, but quail are sought as a game bird with such diligence, that they are becoming extremely scarce. Meadow larks also devour immense numbers of chinch bugs—perhaps as many as do the quail, but here again these birds are also killed as game birds. Prairie chickens, red-wing black birds, cat birds and thrushes also readily feed on chinch bugs.

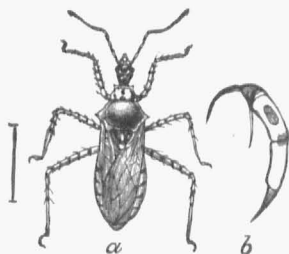


FIG. 4.—A Predaceous Bug, *Milyas cinctus*, which feeds on chinch bugs by sucking their blood. (From Riley, U. S. Dept. Agric.)

There are certain fungoid and bacterial diseases that attack chinch bugs under certain conditions, and these diseases do more good towards keeping the chinch bugs in check than all the other natural enemies of the chinch bug combined. However, we cannot hope to ever see the day in this region of

the United States when the natural enemies of the chinch bug will ever keep it reduced in numbers to within harmless bounds. We must assist nature with her task by artificial means. From what has been said in regard to the habits and the life history of the insect, it is apparent to anyone giving the subject any particular thought, that the chinch bug has several weak places that we may take advantage of.

REMEDIES.

It is advisable that the agriculturist resort to every means possible within the bounds of reason looking toward the suppression of the chinch bug. There can be no doubt, that if all or the great bulk of agriculturists will see to it that proper means are taken each year to hold the chinch bug in check and reduce its numbers, that in the course of a few years the chinch bug will cause no more loss than is caused by a great many other injurious insects. The great difficulty, however, is to educate the mass of the agricultural people up to the point of living up to such rules. The farmers are busy during the summer, and, as a rule, do not feel like taking any time to the fighting of insects. They feel like relying more upon some remedy that can be easily applied, with a hope that it will suffice; and in the great bulk of cases, they will not take the pains to do this in as thorough a manner as they should.

In the first place, every agriculturist should take advantage of the fact that chinch bugs hibernate in the adult condition during the winter under rubbish of various kinds, as before described. If the farm is kept thoroughly clean, and no rubbish of any description, or no hedge fences or other places where the insects can readily hibernate are allowed, then there will be little chance of the chinch bug hibernating on that farm. In other words, clean farming will do a great deal towards les-

sening the number of chinch bugs. If the rubbish of various kinds is gathered from the fields and from about the corners of fences, and placed in piles or in rows early in the fall, and allowed to remain there until the chinch bugs have collected under these for their winter quarters, and these are then burned, vast numbers of the chinch bugs will be destroyed with them. There are a great many hedge fences in this country that contain dead grass and weeds, and rubbish of various kinds, that could well be set on fire late in the fall, and thereby destroy the hibernating bugs. If dead leaves and the like, especially those along the side of forests and other wind-breaks in the neighborhood of cultivated fields that are infested, are burned over in late fall, great numbers of hibernating bugs will be killed.

Then again, if the farmers will sow millet at the proper time so that the millet will be up early in the spring, it will attract the migrating chinch bugs that are coming out from their winter quarters, and they will collect upon the millet in great numbers, and can readily be destroyed by spraying with kerosene, or by scattering straw over the millet and setting fire to it. This millet trap can profitably be used along the border of those places where the chinch bugs hibernate, or along the line separating an agriculturist's farm from his neighbor's.

The practice, which is so common in Missouri, of stacking the corn in shocks in the field, and then cultivating and sowing wheat there, is a very bad one for the chinch bug proposition, because the chinch bugs in such a corn field hibernate under these shocks in vast numbers, probably the bulk of the chinch bugs in such a field seeking this place of hibernation, and in the spring, they have but a few feet to crawl before they are upon the young wheat plant, and in that way the farmer

simply reinfests his fields in as thorough a manner as could possibly be done. Once the chinch bugs are in a wheat field, practically no artificial means can be taken, from an economic standpoint at least, looking towards any help from this evil.

We can not economically kill chinch bugs that are scattered over a wheat or corn field; but it sometimes happens that the chinch bugs in the spring coming from their winter quarters, especially if the wheat field be near a forest, will get upon the first few rows bordering such forests, and collect in great numbers, forming a band but a few feet wide along this area. In such cases, it would pay to spray that badly infested area with kerosene emulsion or ten per cent kerosene, as will be described later on.

A great many people send to this office in the spring of the year for the chinch bug disease, with the idea of scattering this disease about the fields of wheat and killing the chinch bugs infecting them. It is a fact that under certain climatic conditions this chinch bug disease, which, by the way, is nothing more or less than a minute fungous plant, will kill great numbers of chinch bugs. But, from seven years' experience and observation with this disease in the wheat fields throughout the State of Missouri, I am firmly convinced that the artificial use of this disease by the farmers of Missouri does very little, if any, good. This tallies with the experience of other entomologists who have had considerable to do with this matter in other states. While this statement may seem strange to a good many, the reasons are perfectly obvious when properly understood. In the first place, the chinch bug disease is a natural one, found in nature, and is not an artificial one. What we did was to collect the spores of this fungous and put them in boxes containing a great many living bugs. The air and the soil in these boxes were kept continually moist and

warm, and, as a result, the spores readily germinated, and the mycelium of the plant found its way inside the bugs and fed upon them, killed them, and produced spores again on the outside of the bugs. It was these white fungous covered bugs that we distributed throughout the State to anyone applying for them. The persons receiving these bugs were supposed to place them in boxes similar to ours, and keep them under similar conditions, and thereby develop large quantities of this fungous disease, and to scatter these throughout the wheat and

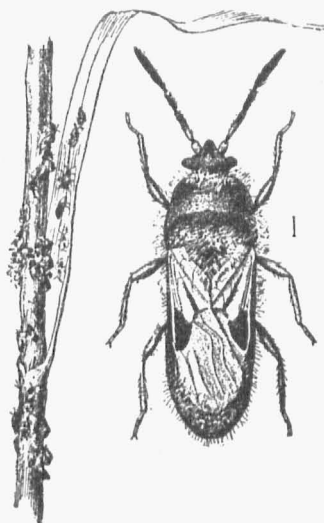


FIG. 5.—Chinch Bug, *Blissus leucopterus*, killed by the fungous disease, *Sporotrichium*. The mycelium is within the bug, and the fungous is starting to develop the white spores on the outside and ultimately cover it. (After Lugger.)

corn fields. As a matter of fact, I have each year found that over half of the farmers do not go to the trouble of cultivating this disease, but simply scatter in their fields the bugs that we send them.

The spores of this fungus require for their germination practically the same conditions that the seed of your wheat

or corn requires in order to germinate, that is, the spores must have a considerable amount of moisture in connection with heat, otherwise they will not germinate. If the chinch bugs are in large numbers and the weather is hot and very moist, these spores will germinate on the bugs, and the fungous plant will kill them in great numbers. But if the weather is hot and dry, or too cold, although it may be moist enough, then these spores will not germinate, and no agriculturist has the power to bring about the proper conditions in his wheat or corn field that will enable them to germinate. Hence you see that, although the farmer may obtain the chinch bug disease and scatter it in vast quantities throughout his field, if the climatic conditions are not right, the chinch bug disease will not take, and will do absolutely no good whatever.

But some may say that in obtaining these diseased chinch bugs from this office, and putting them in their fields, they introduce there the spores that will germinate when the proper conditions are right. I wish to say that it is very doubtful whether there is a wheat field or a corn field in Missouri that does not now naturally contain spores of this disease. I have been impressed with this fact every summer; because, almost invariably, when the person applying for the chinch bug disease sends to this office living chinch bugs that have been placed, as they should be, in a tin box containing no dirt, but some green vegetable matter, as, for instance, pieces of green corn, wheat or grass, and that box closed up as it should be, perfectly tight, thereby generating moisture in the box from these green vegetables, that by the time these bugs reach me, the box contains more diseased fungous covered bugs than we return; thus showing that the spores were already there in his field, and all that was required was the proper amount of heat and moisture in order to enable them to germinate. Knowing

these facts, I can do no other than to conscientiously advise the farmers of Missouri not to trouble themselves with obtaining and scattering this disease about their fields; but to rely entirely, as they ultimately will have to do, upon nature to bring about the proper climatic conditions for the development of this disease in their fields. Even if it were possible for the farmer in any way to develop the proper conditions in his wheat field, then there would be no grounds for him obtaining this disease from any other source whatever.

Bear in mind, that while I can not advise agriculturists to trouble themselves with this chinch bug disease, because of the reasons above given, nevertheless, I am far from claiming that this disease does not do a great deal of good. The facts are, that when the chinch bugs are in a field in great numbers, or massed in places about the field, and warm rains appear, that this fungous disease spreads rapidly through the mass of chinch bugs, and kills them in immense numbers regardless of whether the farmer has ever introduced the spores into the field or not. This whole chinch bug disease then is one entirely out of and beyond the control of the agriculturists. I am perfectly well aware of the fact that it frequently happens, that within a few days after we have sent out this chinch bug disease that the farmer will write back and tell me that he scattered the disease in the field, and that within from two to three days the chinch bugs died in vast numbers, and were all but exterminated. Such letters are of daily occurrence during the chinch bug season; and any one knowing the nature of this disease, and of the chinch bugs, would know at once that the chinch bug disease that he received from us did not cause their death, because of the fact that the time that elapsed from the putting in of the disease to the death of the chinch bugs was far short of the possible time for the disease to take.

This again simply shows that the proper climatic conditions had occurred to cause the disease to develop naturally among those bugs, and before he had introduced it.

Another great error that farmers frequently make is due to the fact that the chinch bug, when it comes to shed its skin and transform from the last nymph condition to the adult, does so after climbing down between little clumps of earth and about the base of the plants, and there casts its skin. It frequently happens that this is done by vast numbers of chinch bugs within a day or two; and the farmer, if he has artificially introduced the disease into his fields, and happens to go out to observe whether the disease has caused any deaths among the bugs or not, notices these cast skins, and mistakes them for killed chinch bugs. This mistake is very readily made, and he immediately jumps to the conclusion that the chinch bug disease that he has recently introduced, has killed vast numbers of his chinch bugs. But there is no need of saying anything further in regard to this chinch bug disease. I think that I have said enough now to enable the agriculturist to see the folly of wasting any time in trying to send for and cultivate and introduce the chinch bug disease into his wheat or corn field.

Chinch bugs cause a great deal of worry on the part of the agriculturist at about the time they are migrating from the wheat to the corn, and, fortunately, this is one of the best times in which to combat this insect. It frequently happens that at this time the chinch bugs migrate in a mass and in great numbers, leaving the wheat field and crawling in the direction of the corn field. When this is the case, whether the bugs are leaving your own wheat field or your neighbor's wheat field, and are moving in the direction of your corn field, this corn field can be protected from the ravages of these bugs without any great amount of labor. This is done by taking ad-

vantage of the fact that this migration occurs almost invariably on foot, that even the adult chinch bugs in the migrating army do not readily take to wing, that these chinch bugs have great difficulty in passing over the loose and unprotected soil, such as a dusty road or a plowed field, and that the hot sun readily kills great numbers of chinch bugs that can find no place for shelter. While it is a well known fact that chinch bugs thrive better in hot and dry seasons and are easily killed or held in check by damp seasons, yet it is a fact that the chinch bugs can not endure to any considerable extent the direct rays of the sun on a hot day. They are, for that reason, found in fields where plants are numerous enough to give them shelter, and are not apt to occur in fields where the plants are scattering and shelter from the direct rays of the sun not so easily obtained.

It is a fact that a migrating army of chinch bugs will be held in check in hot sunny weather by a dusty road, and die in immense numbers before many of them will succeed in getting across. We can take advantage of this fact, and, when we find the chinch bugs are about to migrate from the wheat field to the corn field, plow a belt around the corn field, or at least along the sides toward the migrating army of bugs. This plowed belt should be about ten feet wide. After plowing, the ground should be harrowed with a disc harrow, and rolled so as to break up all the lumps, and then reharrowed, dragging brush after the harrow so as to make this ten foot belt just as dusty as can be made; then a log or a V-shaped trough should be drawn lengthwise along this dusty belt two or three times so as to make furrows running lengthwise. Along one of these furrows at least it is well to dig little postholes, which can be readily done by means of a post-hole auger. When the bugs try to cross this barrier, they will have great difficulty in even

crossing the dust to these furrows. Once they reach the furrows, they will try to crawl out, and, if the furrows have steep and dusty walls, the chinch bugs will not succeed in getting over, but will crawl along the furrows and fall into the holes, where they may be killed by turning on kerosene or tar, or where they may be covered up and other holes dug between.

One will see that the chinch bugs find it almost impossible to pass this dusty barrier, that the hot sun striking them without any protection will kill vast numbers of them, and that just so long as it remains hot and dry, this arrangement will form a complete protection for the corn field. It is well, however, to have one or two men, as is needed, to attend this barrier during each day, and, by means of a hoe, to fix the places along the grooves where the chinch bugs may find places to escape, to see that the chinch bugs do not occur in too great numbers in the furrow or in the holes before they are killed, and to do the utmost not to allow any of the bugs to find places through which they may reach the corn field. It is not absolutely necessary to make these furrows along this dusty belt, although it is advisable.

If one does not make the furrows, or in case it should rain soon after the plowed strip has been made or before the migrating bugs have been captured, one can turn coal tar in the form of a band the length of this dusty barrier and a few inches in width, and, as soon as dried, put tar on again, and so on until the tar will not run down through the soil, but will remain on top, and the chinch bugs will not cross this barrier or band of tar. If it should rain after you have made this dusty barrier and the bugs have collected in vast numbers about it, the rain will undoubtedly start the fungous disease among such a mass of the bugs and practically exterminate them, or you can maintain the barrier by means of the ribbon of tar.

When the chinch bugs collect in good numbers along the dusty barrier, or in the trenches, or along the coal tar barrier, or in case the farmer has neglected to make this barrier, and the chinch bugs have collected upon the first few rows of corn in immense numbers, then he should immediately stop all other work and at once spray those chinch bugs with either kerosene emulsion or ten per cent kerosene and water mixture. In spraying the chinch bugs that have collected in the trenches or along the barrier, one would do well not to wet the dust any more than possible, but spray those places where the bugs are most numerous so as not to destroy the dust as a barrier. It sometimes happens, although not often, that where the bulk of the chinch bugs making this migration are adults with fully developed wings, and find themselves confronted with a barrier, they will take to wing and fly over, and, in such cases they may collect upon the first few rows of corn, where they can be readily killed by means of kerosene.

It is a fact that chinch bugs die like magic before a spray of kerosene emulsion or ten per cent. kerosene mechanically mixed with water; and if we could always be sure that in this migration from the wheat to the corn field, the chinch bugs would collect in immense numbers upon the first few rows of corn, and stay there long enough to allow of spraying them, this would be the ideal method of exterminating them from the corn field, or of preventing them from entering the corn.

An agriculturist should watch the chinch bugs, and when he finds them collected on the first few rows of corn or in masses along his barrier, he should be thankful, because he now has the bugs in the very best condition possible for obtaining his revenge. When the bugs collect in such places, the agriculturist should drop every other work and spray these

insects at once, especially if they are upon the first few rows of corn, since they will soon spread through the corn; and when this happens he is barred from any further method of killing them.

I would advise the agriculturist to purchase one of the new pumps with the kerosene attachment. These pumps are made by the better manufacturers, and cost very little more than the pumps without such attachments. They save an immense amount of time and labor, especially for such purposes as chinch bug extermination. The pumps do away with the necessity of making kerosene emulsion. All that is needed is to turn pure kerosene or coal oil in the receptacle attached to the pump for that purpose, and set the indicator at ten per cent; put the pump in a barrel of water and spray without any further trouble. This ten per cent mixture of kerosene kills the bugs readily, and does not injure the plants.

In spraying for chinch bugs it is necessary to touch every bug in order to kill it, because these bugs are killed by contact with the kerosene. This necessitates thorough work, and one must, therefore, spray on all sides of the plant that is infested with these bugs; but where the bugs have collected in this way in immense numbers, the agriculturist will be delighted to do the work and see the bugs die so rapidly and in such great numbers.

Where one has no modern spray pump with the kerosene attachment, then an ordinary spray pump may be used; but one must make kerosene emulsion. This is made in the following way: Dissolve one-half pound of hard soap (in case you wish to use soft soap one pound should be taken), in one gallon of boiling soft water; after the soap has been thoroughly dissolved and stirred through the water, remove this from the fire and add two gallons of common kerosene or coal oil, while

the liquid is still hot. Remove the spray nozzle from your pump, put the pump into this mixture, and pump the liquid right back into itself. This will churn it, and do so more thoroughly than any other process that we know of. This churning should be done vigorously and kept up continually for ten minutes, at the expiration of which time, a complete emulsion will have been formed, and the liquid will have increased about one-third in bulk; hence the necessity of putting it into a larger receptacle than will exactly hold it in the beginning. After the emulsion has been made, add nineteen gallons of water to it, stir thoroughly, and spray with this.

These two methods of killing the migrating army of chinch bugs when they try to enter the corn field (that is by barriers or by spraying the bugs with kerosene), if followed out, are worth more to the agriculturist than all the other methods combined. In one day, we, in this way, practically exterminate the mass of chinch bugs in the immediate neighborhood, and we do so at a time just previous to the depositing of eggs for the second brood, and, therefore, prevent that numerous increase which would otherwise occur. Hence it would not be unwise to again call your attention to the fact that when the chinch bugs come to migrate from the wheat to the corn, they should be stopped by means of a dusty barrier around the corn field, or, if this can not be done, you should spray them with some form of kerosene immediately after they occur in large numbers on the first few rows of corn.