UNIVERSITY OF MINNESOTA

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## THE CHINCH BUG.

*ST. ANTHONY PARK, RAMSEY CO., MINNESOTA.*

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# THE CHINCH-BUG.

OTTO LUGGER.

There can be no reasonable doubt that this pest will greatly injure our crops of cereals in 1895. During the last year these insects have become very numerous and have migrated to many parts of the state where formerly they could not be found. As these insects use their wings much more freely when leaving their hibernating quarters in the spring, the probability exists that a still greater part of the state will be invaded. At present they are found in nearly all the more wooded districts of the southern and central parts of Minnesota, and only the open prairies have escaped. In the northern part of the state they have invaded many portions of Otter Tail, Wadena, Crow Wing and Pine counties, and are found, perhaps only in exceptional cases, even in the pine regions still farther north. In fact, they were found upon several small farms near the shore of Vermilion Lake, where the only agricultural products were potatoes and a little timothy. In one case a patch of timothy surrounded by evergreen trees was utterly ruined by them, and close questioning brought out the fact that chinch-bugs had been causing similar damage to the same patch for at least three seasons, thus plainly proving that this insect can survive even exceedingly cold winters without being much injured. As far as our prairies are concerned, those adjoining the wooded banks of rivers and lakes are more or less infested with this pest; and as the windbreaks offer excellent shelter for it during the winter, there is danger that the chinch-bugs will invade a steadily enlarged territory.

The past history of the chinch-bug teaches us that its increase and decrease may be compared with ocean waves striking a shore: at first a gentle swell, then a small wave, followed by a tremendous breaker. In other words, it takes a number of years before the insects become numerous enough to cause immense losses. Like the sudden collapse of the breaker, chinch-bugs, having reached the period of greatest destructiveness, also become suddenly reduced in

numbers and are past doing harm for a number of years. This forecast would be a very pleasant one if the bugs in Minnesota had already reached this culmination point of their increase, which unhappily is not the case, and we may reasonably expect increasing trouble for at least two years. Past experience has shown that we may expect at most two chinch-bug years in every seven years, with the strong probability that there will not be two in succession; it is only a pity that this rule should never have exceptions, which, however, it has. At all events, such experience ought to warn us to be always prepared for the enemy and to apply remedies in time and not wait until too late.

The cause for this rapid increase in their numbers was evidently the exceedingly dry and warm season of 1894. Even the oldest inhabitant of the state does not recollect a season like the past one, which is a singular fact considering how apt some wiseacres are to recollect things—in imagination. In many portions of the state rain fell only at very rare intervals and dew was almost unknown. If it had not been for the frost in May, following very warm and moist weather, which forced the roots of cereals to penetrate deep in a soil warmer than the air, damages by the drouth would have been still greater. It was really surprising that plants could grow at all during such a season. The dry and warm conditions of soil and air are just the conditions chinch-bugs require to thrive and to multiply, and from the few bugs found here and there in isolated localities sprung the great and almost connected armies of chinch-bugs found late in 1894. Yet notwithstanding these favorable conditions for the existence of these bugs, farmers lost, comparatively speaking, but little on their account, simply because the earlier cereals, such as barley, wheat, rye, and even oats, matured much sooner than usual, and thus became unfit for their food.

After injuring to some extent the corn, or causing in some cases a total loss of that important crop, and after destroying such grasses as the different kinds of pigeon grasses, to the latter of which they were decidedly welcome, the chinch-bugs moved about in search for suitable shelters under which to pass the winter. A large number of such shelters have been investigated in various parts of the infested regions, and almost invariably with the same results: immense numbers of chinch-bugs were found snugly hidden, ready to commence their destructive operations early next spring. In most cases

the great majority of these dormant bugs were found to be decidedly healthy, and only in some localities a disease is silently at work reducing their numbers. Diseased bugs were found in their winter quarters only in regions where a disease had been spread artificially in 1894; not a single diseased bug has been found elsewhere.

*Life History of the Chinch-Bug.*—It seems to be unnecessary to give the life history of such a well known insect, which has repeatedly caused such vast losses to part of our state, but a large number of our farmers have had thus far no opportunity to become familiar with their enemy. This is chiefly true of regions not yet or only quite recently infested, and where this tiny insect has not been discovered to be such a formidable foe. That many farmers, even living in regions where chinch-bugs have caused considerable damage, do not yet know this pest is plainly proven by the fact that all sorts of insects are sent to this Station with the question: Is this a chinch-bug? Among such specimens received are insects which do not resemble chinch-bugs in size, shape, color or general appearance, but all are fairly large, showing that small insects are considered too insignificant to annoy the "crown of creation." Yet it is among the smaller insects that our greatest enemies are found. A large number of small insects, but mainly bugs, are frequently mistaken for the genuine chinch-bug, simpy because they smell bad. Chinch-bugs have, indeed, a bad odor; but other bugs produce the same or a worse by being squeezed. In illustration Fig. 1 are given all the different stages of this insect, and by comparing a doubtful specimen carefully with these figures farmers not yet familiar with the chinch-bug will have no trouble in ascertaining their true character.

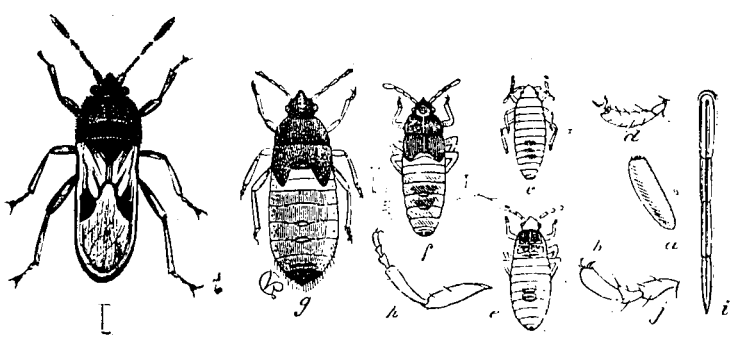


FIG. 1. Different stages of the Chinch-Bug, showing Egg, Larva, Pupa and Adult. After Riley.

The adult and winged chinch-bug (*Blissus leucopterus*, Say.) is three-twentieths of an inch long, and has a black body covered with a very fine grayish down, too fine to be plainly visible to the naked eye. The four-jointed feelers possess a honey-yellow basal joint; the second joint is tipped with black; the third and fourth are black. The beak, when not in use, lies hidden between the legs, and is brown. The wings and wing-covers are white; the latter have near the middle two short, irregular black lines and a very conspicuous black spot near the margin. The white wing-covers, with the contrasting black spot, distinguish the chinch-bug from all other bugs found in Minnesota. Of course, whenever an insect becomes so very numerous as the chinch-bug, many forms can be found which vary somewhat from the description given. Even forms may be found which possess only rudimentary wings, and this is most frequently the case in the first generation, when these insects do not readily use their wings. The black spot upon a white ground is, however, always plainly visibe.

All chinch-bugs pass the winter in the adult, winged or perfect state, never as eggs, larvæ or pupæ. Towards autumn, when their food supply, such as corn and wild grass, becomes too dry to furnish sap, the bugs are forced to search for some convenient and suitable shelter in which to pass the winter. But in doing so they seem to know exactly what is a suitable shelter and what is not. The aim of all seems to be to find a dry situation; one that is either somewhat elevated to afford good drainage, or one composed of such soil as sand, that will permit moisture to disappear quickly. In such situations the bugs hide under dead leaves, bunches of tall grass, under all sorts of rubbish, under logs, stones and clods of earth; they also find shelter under haystacks, strawstacks, corn shucks—even under loose bark of trees and in outhouses. Most chinch-bugs hide near the edge of woods growing upon an elevation, under rubbish upon sandy soil, or under the mulching in windbreaks. Here they remain torpid during the cold weather, but during a continuous warm spell in winter they are apt to move about a little, perhaps to find still warmer quarters. Extreme cold weather has no terrors to chinch-bugs; in fact, the colder the winter the safer they pass it, providing, however, that no repeated thawings and freezings take place, which will injure their vitality. A bug that can safely winter upon the shores of Vermilion Lake cannot be frozen to death by any weather that may occur elsewhere in Minnesota. Last winter a

number of chinch-bugs were found hidden in a short bunch of grass in a lawn, and by sprinkling water upon bugs and bunch the ice formed at once, keeping the bugs hermetically sealed for several months. Upon thawing this ice the bugs acknowledged their obligations by destroying some tender and choice grass plants. The general opinion that a severe cold winter will decimate our insect enemies is based upon no facts; on the contrary, an open winter, with repeated thawing and freezing, is more apt to assist us against this enemy, but to what extent it is impossible to state.

As soon as the soil becomes warmer towards spring the bugs show greater activity during the warmer portions of the day, and are very apt to crowd together in spots particularly warm. At this time they do not yet require food. But as the nights become also warmer they commence to show their appetite by tapping the tender grasses now appearing. Towards the end of May, though sometimes much earlier or later, according to the climatic conditions of the season, the bugs become decidedly active. In exceptionally early and warm springs, mating takes place in many cases before leaving their hibernating quarters, though as a general rule it does not occur until breeding places have been selected. During a long-continued warm and dry autumn, mating chinch-bugs are not so very uncommon, yet such cases are an exception, not a rule. When the proper time arrives, all the bugs take to their wings and fly about in search of food for themselves and for their prospective offsprings. Not infrequently the air is filled with their winged bodies, and this is sometimes the only time that they attract general attention, as they frequently entirely cover horses, wagons and persons. This is a critical period for fields that have so far escaped their ravages. As the weight of such bugs is but slight, they can be carried away by the winds to very distant localities. In fact, the stronger the wind at this time the farther the trouble may spread. This no doubt accounts for the presence of the chinch-bug in regions but poorly adapted to their requirements; for instance, in isolated meadows surrounded by dense pine forests. This is also the time when the otherwise safe western prairies of our state may be invaded for the season, and if sufficient shelters can be found in windbreaks the pest may be established in this newly conquered region for several years. Such flights only take place when the air is dry, and only during the heated portion of the day. The reason for such flights is self-evident; they are made to find feeding places for themselves and for their

offsprings. But not every field with inviting young plants of barley and wheat has attraction for such insects; the fields must be of a certain kind. Fields with a sandy soil, well drained by being situated on a knoll, and which warm up readily, are preferred; or fields that either from being poorly cultivated or from being more or less exhausted of vegetable food, have a poor stand of plants. Such fields are almost invariably selected simply because the soil is exposed to the direct rays of the sun, and because chinch-bugs dearly love warmth and dryness. When settled in their new home the bugs make up for the long fast enforced upon them by the winter, but soon afterwards the sexes commence to mate. Those that had already mated soon commence to deposit eggs, and thus the egg-laying season lasts four weeks or more. A field may contain untold numbers of bugs and yet have but very few visible, and those nearly all in the act of mating, which usually takes place upon the ground. By shaking the plants—or, better by pulling them up with their roots—the true state of affairs will become painfully visible. The great majority of the bugs enter the ground for protection, and obtain their food by tapping the lower parts of the stalks of grasses and cereals. Though not equipped with legs fit for digging, they find an entrance near the plant, made for them by the swaying of the stems in the wind. Here they enter and make their homes, surrounded by plenty of food—the sap of nearly all species of the grass family.

*The egg* is rather large for such an insect, measuring about 0.03 inch; it is elongate oval, with the diameter about one-fifth the length. By observing such an egg with a powerful lens, it will be found quite a pretty affair. It has a squarely docked top, surmounted with four rounded tubercles near the center. As long as quite fresh, it is pale, whitish and translucent; as it grows older it becomes amber colored, and towards the period of hatching the red parts of the future insect, but especially the eyes, are very plainly visible towards the top. These eggs are almost invariably deposited upon the roots of the plants selected, and only exceptionally can they be found upon the withered sheaths near the base of the stalk. As the eggs are usually deposited in small clusters, they are readily detected with the naked eye. By pulling up such plants and inspecting carefully the roots and base of stalk, the eggs appear as glistening objects of amber or red color, quite distinct from similarly colored grains of sand. Of course a large number of the eggs become de-

tached and remain in the soil when pulling the plant, so that those counted give by no means a true estimate of the numbers really present. It is claimed that each female can deposit as many as 500 eggs. When we consider that the egg-laying period of a female bug extends from ten days to four or five weeks—in some cases over even a longer period—and that eggs may constantly mature in the ovaries, this large number is very likely to be only too correct. There is considerable difference in the length of time required to hatch eggs. Last year eggs deposited quite early in June remained almost three weeks in the ground before hatching; later the hatching time was considerably shortened by more favorable weather, and the eggs hatched on an average in two weeks. Eggs of the second laying hatched, in some cases, inside of ten days, everything being in favor of a rapid development of the embryos.

*Larval Stages.*—As soon as the young larvæ hatch they lose no time in inserting their beaks to obtain the liquid nourishmnet of the plant. This action frequently takes place before the young bug has seen the light of day. Of course a great deal depends upon the weather existing at the time. If warm and dry, the young bugs work their way towards the surface and usually insert their beaks in the stalk just above the surface. The character of the soil has also considerable influence in this respect. The newly hatched larva is pale yellow, ornamented with an orange stain upon the middle of the three larger abdominal joints. A glance at Fig. 1 will show this, as well as the other differences pointed out later. In shape this young bug resembles the adult insect, being but slightly longer in proportion. Yet it differs in one point essentially from the adult by having but a two-jointed foot. Of course this otherwise curious difference will not greatly interest the farmer. As the infantile bug grows older the red color soon pervades the whole body, except the first two abdominal joints, which remain yellowish. As the larva enlarges it soon outgrows the outer skin, which can not expand, and the insect is forced to throw off the old coat and wear a new one of a bright vermilion color, in strong contrast with the pale band across the middle of the body. Growing rapidly, the larva has again to undergo a second molt, after which the new coat shows a dusky head and thorax. At this time the future wings become indicated by small, dusky wing-pads. Molting a third time, the pupal stage has been reached. The pupa has a brownish-black head and thorax, larger wing-pads of a similar color, a dingy gray abdomen, and a

dark horny spot at tip of abdomen. The entire body is also slightly pubescent. The pupa, as well as the larva and adult, takes food by inserting its beak in the food plant.

The adult bug has already been described. It is distinguished not only by having a different color, but by being larger, winged, sexually mature, and by having one toe more in each foot. As already mentioned, a great number of somewhat differently colored and shorter winged forms have been described, but none are of a pleasing aspect to the farmer.

The time required to transform a freshly deposited egg into an adult bug varies greatly in different seasons, as might be expected in case of an insect so fond of warmth and dryness. In wet or cold seasons it takes much longer, but if conditions are favorable these changes may be passed through in fifty-six to sixty-two days. Sometimes, long before the last produced larvæ have reached the adult or even the pupal stage, such food as rye, barley and wheat becomes too ripe to furnish the needed sap, and the bugs are forced to travel in search of plants more suitable for their food.

*Migration.*—The above accounts for the peculiar fact that the migrating armies of chinch-bugs, when leaving the fields of small grains for those of green corn, are composed of all ages, forms and sizes. In some cases nearly full-grown larvæ compose the majority of the army; again, small and large larvæ and pupæ form the bulk, but most usually a large number of adults are among the migrating insects. Climatic conditions and the resulting fitness or unfitness of the food-plants are the main cause of this peculiar state of affairs. As a very general rule, such armies do not and can not travel very fast nor far, and seldom a distance of over one hundred rods is passed over. Of course, hunger is a very severe prompter, and almost all bugs leave a field no longer furnishing food at nearly the same time, and all—prompted by the same sense or instinct—move in the same direction, and almost invariably to the next field of corn. What this sense may be is difficult to state; perhaps an acute sense of smell, perhaps some sense we do not know anything about, not possessing it ourselves. Notwithstanding the fact that the adults found in such an army possess wings, they use them but very seldom, and only when the air is very warm and dry. Such winged insects may fly to the next source of food, or may be blown by the winds arising during their flight to far-away regions, to form the starting point of a new colony or a new army. All attempts to force such winged

insects to fly are of no avail; they evidently trust more to their legs than to their wings. An army of migrating chinch-bugs would be a sad sight if they were friends and not enemies. They appear foot-sore and dusty, and surely are hungry and thirsty. The individuals move rather quickly, and readily overcome common obstacles that may impede their march. But if they encounter dusty paths and roads, or newly plowed, dusty fields, they have a desperate task before them. In such dusty places, heated by the direct rays of the sun, and not compressed by rain or dew, their progress is necessarily but slow. As they move their front feet forward, grasping a particle of dust, this latter gives away and is pulled towards the insects whenever they attempt to press forward. Thus a dusty road becomes an obstacle almost impossible to cross. Yet the hunger and thirst permits no cessation of work, and many insects will at last succeed in overcoming all obstacles. A heavy dew, or a slight rain, is of course of great assistance to the moving army, and a dusty road no longer is impassable. The sun, which chinch-bugs enjoy so much at other times, becomes at this period a source of great danger, and many of the younger and less efficiently protected bugs die in consequence. All these facts ought to point out to the farmer many a method by means of which he can conquer his enemies. In the end, all obstacles are surmounted by those bugs that did not perish from hunger or heat, and the surviving members succeed in reaching the land of plenty—a waving field of corn, with vivid green and succulent food. Nor are the bugs slow in utilizing these new stores, and they are so hungry that they settle upon the first plant they reach. Soon the famished army covers the outer rows of plants of a cornfield, and we can now for the first time realize how numerous they were in the fields abandoned by them, since the scattered insects are now concentrated upon a few and large plants. These plants of corn soon turn black by the very presence of the insects. At first only the base of the stalk is thus crowded, as the tired bugs attacked that part of the plant reached first; but soon afterwards the whole plant, to the very extemities of the leaves, is covered with them. Their united action forces all the sap of the plant to the outside, and as there is at first usually more sap than the bugs can well imbibe, the spaces between the sheaths of the leaves become filled with fluid, which in a very short time ferments and sours. If the bugs would simply be satisfied with imbibing sap, they would greatly injure the plant; but they cause still greater damage by injecting some

poison which browns or blackens the leaf surrounding the part injured by the beak. Thus even comparatively few insects, not numerous enough to kill a plant, will cause it to wilt or die by the action of this poison. A similar action can be observed in a domesticated species of bugs not seldom found in beds. These insects, instead of thriving upon vegetable sap, prefer that of animals, and to fill their hungry stomachs as quickly as possible they insert their beaks into the human skin, inject an irritating poison to cause a local inflammation, and thus force a rapid flow of blood to the injured part. Perhaps for a similar reason is poison injected into plants by chinch-bugs attacking the same.

Gradually the chinch-bugs of this first generation mature, and, after mating, deposit eggs for a second and last brood. These eggs are usually deposited behind the old and withered sheaths of the lower leaves, where they may be found quite readily, and in large numbers, not being so much hidden by particles of soil as those laid earlier in spring. Under such sheaths the young bugs hatch and feed, sometimes even undergoing all their metamorphoses to the adult stage. Most larvae, however, leave these shelters, because they are too crowded, and search for more suitable places upon other plants. In this manner soon most of the plants in a field are crowded, and suffer in consequence. The outer rows of corn, so thrifty looking at first, soon cease to furnish food, and after the insects have left appear white and bleached. In very severe cases, a cornfield badly infested can be distinguished from all others by this bleached appearance; and, as this usually happens during our hottest and dryest season, even repeated showers of rain are unable to strengthen and revive such plants. Whoever wishes to study the power of insects to destroy and to increase needs only to pull down a leaf of a corn plant infested with chinch-bugs. He will find, snugly hidden beneath the sheath, immense numbers of these insects, together with the discarded coats of the earlier stages of this bug. In course of time all these insects mature, and as their supply of food commences to flow more sparingly, or ceases altogether, it is time for them to search for shelters under which to pass the winter. Many of the insects remain for this purpose under the very sheaths that offered them shelter and food thus far, but the great majority now make good use of their wings and scatter far and near. As their usual winter quarters have already been described, it is not necessary to repeat.

This is, in a general way, the life history of the chinch-bug. It varies somewhat in details in the different regions or in different seasons, but as far as Minnesota alone is concerned, no essential facts have been omitted. It might be added, that during their migrations to the cornfields, these injurious insects become useful by destroying all the pigeon grass growing in the abandoned fields and upon the route over which they pass.

*Vulnerable Points in Their Habits.*—When we consider the life history sketched above, we find that a practical person will be very apt to discover some habits that could be utilized to kill large numbers of this pest. Considering the fact that these bugs find shelter under all sorts of rubbish, leaves, etc., it appears assuredly feasible to attack them there with good results. Clean farming, then, is not only goodly, but an excellent remedy against this insect, and against many others. Let every farmer do his share of the work by not permitting any rubbish to accumulate upon his farm. In our usually dry autumns all rubbish will burn well. Such material should be raked together in rows; this should be done before the bugs search for shelters, and as they surely will find such rows, they will not be slow to appropriate them for winter quarters. Later, rubbish and bugs can be disposed of by fire. This work should include the clearing and cleaning of the edges of the woods, of fences and fence corners, of haystacks and straw-stacks, of windbreaks; in fact, no rubbish should be permitted to remain upon the farm; and no rubbish means no shelters for the bugs. Besides this all the taller grass should be burned over; in fact, let the fire be anywhere and everywhere excepting where it might be dangerous. This burning of dead foliage upon fields, meadows and prairies in former times accounted, to a great extent, for the absence of many injurious insects at present only too common.

We know that chinch-bugs prefer certain plants and dislike others; they prefer millets, for instance, and almost invariably attack this plant when found in the infested region, while flax repels them. It seems that barley is their second choice, then wheat, and later in the season corn. Winter rye frequently escapes harm, as it usually ripens too early, though a great deal depends upon the season, and rye may be destroyed by preference. Chinch-bugs do not like oats. This does not mean, however, that oats will invariably escape their ravages. On the contrary, if more suitable food should be scarce, chinch-bugs consider oats good enough for them, and act

accordingly. By sowing millets very early, and having it above ground before the bugs leave their winter shelters, they will assuredly find and appreciate it, and will settle there in very large numbers. Of course, the owner of such millet cannot expect to grow both a crop of millet and of bugs, but will be forced to sacrifice the former to kill the latter. Just before the millet becomes too hard for the insect, it should be cut and left upon the soil. The bugs remain upon it for some time before realizing the necessity of migrating, and this delay should be utilized to burn millet and bugs.

Another point in the life history of these bugs is their love for warmth and dryness, and consequently their selection of fields offering both. Chinch-bugs prefer sandy soil or poorly cultivated soil simply because in such fields the plants are small and of irregular growth, thus permitting the sun to strike the soil directly, it not being shaded by foliage. Fields well covered with plants, and consequently soils well shaded, are not attractive to these insects. A good farmer will not utilize soils of the above characters, but will enrich the sandy soil to such an extent as to produce a strong and uniform stand of plants; nor will he cultivate poorly a good soil; neither will he be a robber of the soil by continuing to remove crops year after year without returning something to the soil in form of manure to keep up its fertility. A good farmer will escape many losses by insects and other pests where a poor farmer would suffer. Good farming, and clean farming, should be the motto over every farmer's door. Poor farming means also a rank growth of weeds, and mainly of the different species of pigeon grasses, which in themselves are a great attraction for chinch-bugs.

Another point in favor of the good farmer, or of one who feeds the soil generously, is a return of the thankful soil in form of strong and vigorous plants; plants which can withstand the attacks of injurious insects much better than the weak plants growing upon a starved soil.

As long as it is the aim of the farmer to grow upon the biggest scale possible only one kind of crop, just that long noxious insects will be numerous, or even increase still more in numbers. The reason for this is so self-evident that it is not even necessary to explain. If more diverisified farming was the rule and not the exception, as it is at present, fields containing the same kinds of plants would be more or less widely separated by fields containing other kinds of plants, and insects would not find it so convenient to multiply with-

out let or hindrance. Such fields of cereals, separted by other fields containing other crops, would soon reduce the numbers of many insects, and among them those of the chinch-bugs. Of course, this would mean, perhaps, more work, but it would also mean less trouble and better returns for the labor expended.

When we consider the method in which the bugs of the first brood migrate from the dry plants first infested to the future green food in cornfields, we are struck with the fact that nearly all bugs, whether large or small, migrate on foot, and that even the great majority of the winged ones do not form an exception by using their wings. Of course, under certain conditions a small percentage take to their wings; but this is the exception and not the rule. Armies of insects migrating on foot, and moving slowly and in the same direction, should offer us many opportunities to oppose or to stop them entirely. This very fact of migrating on foot is the weak point in the life history of the chinch-bug, where we can, with a little foresight, overcome them. Many different methods may be adapted, depending mainly upon the character of the ground over which the insects have to pass. In our own state the agricultural soils are usually quite free of rocks and stones, excepting certain localities where they abound, but where, in consequence, but little grain is grown. By making between grain and cornfied a ditch several feet in depth, immense numbers of bugs can be captured and killed; in fact, nearly all that travel on foot. But in dry summers such ditches will have sides composed of baked and hard soil, and would offer but a slight hindrance to the moving army beyond extending their trip over a little greater distance. It is therefore necessary that the sides of such a ditch should be smooth and that its bottom should be very dusty. This latter is easily managed by tying together a bundle of twigs, with the leaves still adhering, and by dragging this bundle repeatedly through the ditch until the desired conditions have been made. The spade should be used to rectify any defects in the smooth sides. If such a ditch cannot be made, one or more very deep furrows should be plowed, and by using bundles of twigs their bottoms should be made very dusty. Very fine dust will perform the work most thoroughly. As already mentioned, it is almost impossible for a bug to cross such a dusty strip. Many modifications of this method are possible and will suggest themselves to the thinking farmer. Even a strip of plowed land, made perfectly level with a disk-harrow and thoroughly rolled by a heavy roller and made

dusty, will do wonders. All these methods have two ends in view: to stop the progress of the bugs and to collect them in large numbers in a limited space, so that they may be killed. This latter can be done in various ways. If ditches are used, a little straw scattered in the bottom will soon be crowded with bugs; in fact, piles of straw seem to confuse the traveling bugs and retard and retain them for some time. The straw can be burned by adding a little kerosene oil. Or, by means of a post-hole augur, holes can be made every ten or fifteen feet, into which the bugs will collect or into which they may be swept. By closing such holes when filled with bugs and making other holes, or by killing the bugs in the holes by kerosene oil and cleaning them afterwards with the augur, the bulk of the army can be captured and disposed of. As the bugs will not cross coal tar, the edges of furrows or ditches towards the fields to be protected should be covered with this material, and none of the insects could leave the trap. This coal tar can also be used even without a ditch or furrow, but will not be so effective; yet in certain and extreme cases it may be the only method that can be used in time. By pouring a broad line of this material upon the neutral zone between the fields, and by keeping its surface fresh, the bugs will gather in front and can be trapped in holes made for this purpose. If all such measures have been neglected, or if the bugs have already reached the outer few rows of the corn, the plants in them should be cut down in such a way that they form more or less continuous piles upon the ground. The bugs, being starving, will not leave these stalks for some time, but will continue to find their sustenance upon them. This, for quite a while, prevents their moving to the next rows of corn. The bugs can be killed in very large numbers by burning dry straw between the piles of corn cut down. A little kerosene oil, or any other substance that burns well and makes a dense smoke, will make a very pleasing addition to the entertainment. Knowing the principle to be applied, every thinking farmer ought to know how to apply it to the best advantage upon his own fields. The very fact that the bugs are retarded for a long time upon the heated surface of the ground is sufficient to kill a large number. The same principle explained above, but in another form, was applied by the writer six years ago upon the fields of the Experiment Station, and with such marked success that the corn to be protected did not suffer in the least from the chinch-bugs, though they almost surrounded the cornfields in immense numbers. The description of this particular case will be quoted later.

It seems strange that sensible farmers, who have been told again and again, should fail to make use of such a very simple and cheap remedy, simply because it requires some extra work. And yet this work is required to be done at a time when other farm work is not so very pressing. If these methods were only generally and conscientiously followed, there would be no need to apply other remedies; and not alone would the corn be saved, but in saving it the second brood of chinch-bugs would be very materially reduced in numbers, and in a short time the chinch-bug would cease to be the destructive insect it now is. As this method is such a good one, it bears repetition: all that is required is a thoroughly dusty surface, best in a depression especially made for that purpose, and that this dusty surface should be attended to diligently, so that repairs can be made whenever necessary. A ditch or furrow left unattended will be made in vain.

Although most of the direct remedies—the insecticides now in general use—will prove of but little value, we should except the kerosene oil emulsion, which can be used very successfully in certain cases. If the migrating bugs have reached the outer rows of corn, and almost hide these plants by their presence, this material will prove very effective; and as it will cost less than 75 cents per acre, it should be used much more generally. The emulsion should be well made, and it will be found best to use the one made after the Hubbard formula, which is here repeated:

| | |
|---|---|
| Kerosene, 2 gallons | 67 per cent. |
| Common soap or whale oil soap, one-half pound) | |
| Water, 1 gallon) | 33 per cent. |

"Heat the solution of soap and add it boiling hot to the kerosene. Churn the mixture by means of a force pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream which thickens on cooling, and should adhere without oiliness to the surface of glass. Dilute before using one part of the emulsion with nine parts of water. The above formula gives three gallons of emulsion, and makes, when diluted, thirty gallons of wash." To do the work thoroughly, farmers should use this wash at the rate of about sixty gallons to the acre.

*Relation of the weather to Chinch Bugs.*—Most persons have the impression that a very severe and cold winter would prove fatal to chinch-bugs. This impression or belief is not borne out by facts, which prove that the opposite is nearer the truth. An uniformly

cold winter, and a more or less deep covering of snow, are the very conditions that chinch-bugs require to pass the winter in good health. As soon as the cold weather begins, they become torpid, and remain so until spring. If, however, we have an open winter, with little snow, or long mild spells warm enough to wake up the torpid bugs, followed by very cold periods, or if we have frequent freezing and thawing, then the bugs suffer more or less severely, and their vitality becomes impaired and weak, and they are ready to succumb to any disease that may attack them. This is especially true if large numbers of bugs crowd together in the same hibernating quarters. It seems as if a deep covering of snow was essential to their health. Yet immense numbers of bugs remain frequently unimpaired and healthy without such a cover, and wake up quite active in spring, not showing the least ill effect of such a long exposure to cold. If we investigate such hibernating places we soon discover that they are dry, or that they are well drained. It seems, then, that it is moisture more than cold that chinch-bugs try to escape. They are not easily killed when in a state of torpidity, and we can have no assurance that they may be killed by the inclemency of our winters. Their love for dry shelter accounts for the fact that a long continuous wet spring is fatal to their health. They cannot escape this moisture, and large numbers of bugs can be found dead after such a rainy spring. This accounts, also, for the fact that a rainy season usually causes the end of a chinch-bug invasion. The insect becomes weak and the prey of various diseases which seem to be always ready to attack bugs with an impaired vitality, and during such seasons the great majority of bugs are killed. An uniformly cold winter, with much snow, an early spring not too wet, followed by a warm and dry late spring and a still warmer and dry summer, are the essential climatic conditions favorable to a rapid increase of chinch-bugs. Knowing that immense numbers of chinch-bugs are now sheltered in their winter quarters, and that at the present time (Dec. 10, 1894) they are still in a most healthy condition, it is to be feared that a considerable part of next year's crops will be subjected to their ravages. As we cannot tell beforehand what kind of weather will prevail in spring and early summer, and as rain-makers have apparently lost a control they never possessed, it well behooves us to make all the preparations necessary to fight the enemy. Every farmer ought to be willing to do his share of the work, and by carrying out conscientiously the different methods given above—all

based upon the habits of that enemy—very much may and should be done. Yet the millennium has as yet not been reached, when every farmer will be educated and willing to undertake such work, and we must therefore depend upon other remedies, which should be applied largely by the state for the benefit of the entire community, as large crops are the mainspring to the activity of every other business besides that of farming.

It is well known that the area of wheat and of other plants belonging to the family of grasses stands in the same relation to losses caused by chinch-bugs as cause to effect. Districts in which most wheat is raised feel the damage first and most severely; those in which wheat and oats are the principal crops next receive the brunt of the insect attack; and the last to be seriously affected are those in which corn and grass are the leading products (Forbes). In a region in which stock-raising and dairying are the leading agricultural pursuits the bugs are less liable to cause damage than in a region in which small grains are the staple crops. Prof. Forbes has also demonstrated that large areas of oats could be successfully grown, but in corn-growing regions most small grains should be left alone, and, above all, winter wheat and barley.

*Diseases of the Chinch-Bugs.*—Considerable attention has been paid during the last ten years to a number of diseases that are known to be fatal to such bugs, and considerable progress has been made in their application. Such diseases have been studied, and methods have been invented in which they can be increased and spread among their victims. Still, a large amount of work and innumerable experiments have to be made in this direction, and it is still an open question whether we shall ever so fully succeed as we wish to. None of these diseases can be called as yet a true remedy, as we can do but one part of the work, while climatic conditions must do the other. It is easy enough to produce any amount of fungi causing such diseases, but we cannot produce the necessary weather to make it effective. All such diseases seem to require two distinct conditions: a fair amount of moisture to make such plants as fungi thrive well, and a somewhat lowered vitality of the bug to be attacked by the disease. Under artificial conditions we have control over both, and can consequently produce from a few fungi a very large number of diseased and fungus-covered dead bugs. But when we introduce this material among the healthy bugs found in our fields we lose control of the necessary conditions and have to depend upon the weather that may be prevailing at the time. If this is in favor of

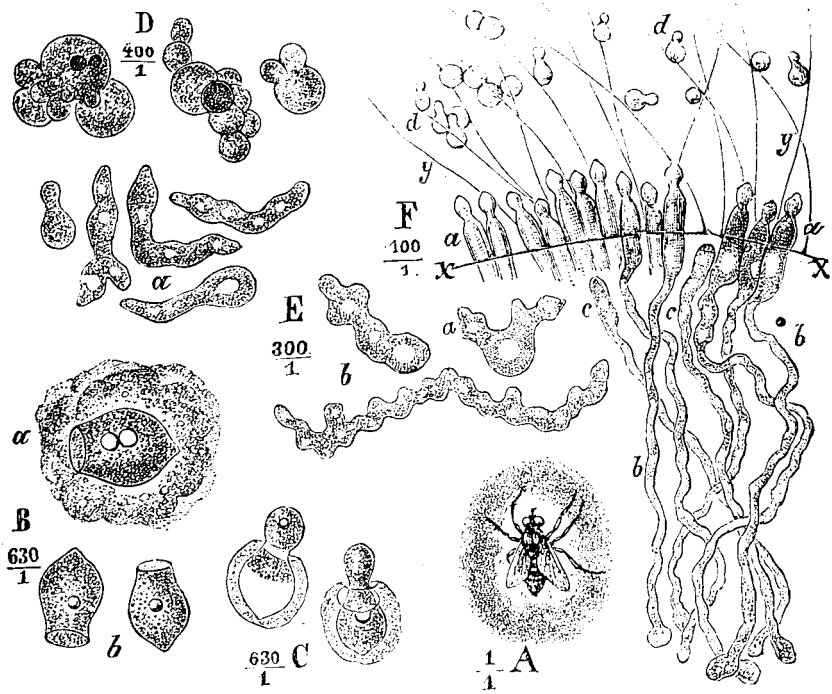



FIG. 2. Disease Killing the Common House-Fly.

the death-dealing fungi, the introduction of a disease will be a success; if not, it will do but little good. In other words, if the disease is introduced when the weather is favorable, good results will follow; if dry, none may be expected. As the diseases are chiefly active during the warmer portions of the season, they make but slow progress during the time that the bugs hibernate; yet late summer and autumn rains have a tendency to promote the development of a very virulent disease of the bugs, the *White Muscardine*. Persons who are in the habit of watching such things have no doubt observed how rapidly our common house-flies are killed by a disease prevailing in September. Not infrequently we may at this time observe a fly fastened by its tongue to a pane of glass in a window, surrounded by a white, flour-like dust. If the fly is removed, its body will be found hollow. This white dust is in reality composed of spores of a fungus which grew inside the fly, and after killing its host, forced its way to the surface of the same and scattered these spores, again fatal to other flies that may come in contact with them.

The disappearance of the multitude of flies early in September is not owing directly so much to the colder nights that prevail at that time as to the disease and death-producing fungus. We do not observe this disease during the warmer portion of the year, simply because the vitality of the flies will permit them to escape this contagious disease. But as cool nights become the rule and not the exception the vitality of the fly is lowered; flies crowd together in large numbers ,are more or less sluggish in all their actions, and consequently the disease requiring such conditions can attack and kill them. The same holds good with all diseases of this nature that attack chinch-bugs; perhaps it is the general rule with all diseases caused by such small parasitic organisms.

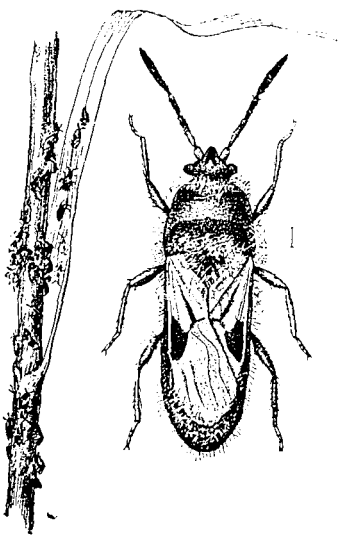


FIG. 3. Chinch-Bug Killed by Entomopthora.

FIG. 4. Bug Covered by Mycelium of Sporotrichum.

In Fig. 3 is shown a chinch-bug, greatly enlarged, that was killed by a species of fungus (Entomophthora), and which was the cause of the sudden disappearance of chinch-bugs from the state in 1888. As the case was a very interesting one, showing at the same time another method to prevent bugs migrating from the neighboring cornfields, the statement made at the same time is here repeated: "Oats, rye, wheat and some grass was utterly destroyed by them. and the young and promising corn formed now a standing invitation

to the hungry hordes. To prevent their inroads, all the infested fields and experimental plats were surrounded by a low board fence, six inches high, and snugly fitting to the ground, so as to prevent the insects from crossing under this fence. The upper edge of the boards were painted from time to time with tar, which prevented the bugs from crossing. The insects were at this time of all sizes and ages; adults of the first brood, young hatched bugs and pupæ were all mixed together, and all were decidedly hungry, as their intense activity and the swarming armies of famishing bugs plainly indicated. To gather in this crop of bugs, round holes, about six inches in diameter, were drilled in the ground close to the fence, and as one hole became filled with insects it was closed and another one was opened close by for the reception of more victims. So matters worked to our satisfaction, when an unexpected assistant came to help us, making the construction of more fences unnecessary. The above-mentioned holes were quite deep, and consequently were all wet, a condition of things not at all suitable to starving chinch-bugs, and they soon became unhealthy and weak, thus presenting the best conditions for any disease to claim them as its victims. And such a disease, produced by a fungus, was not slow in making its appearance, as could be seen by the numerous dead bugs. The margins of the holes, but chiefly those most densely crowded with captives, became whitened with dead bugs, enshrouded in white mycelial threads and dust-like spores; in fact, in a few days the upper rims of these holes looked as if recently whitewashed. Nor did the disease stop there! On the contrary, it spread very rapidly to adjoining fields of timothy, Hungarian grass, millet, etc. Even the course followed by it from the holes could be readily recognized for some time by the more or less numerous white spots left in its wake. The fields invaded by the disease afforded, upon closer examination, a truly edifying spectacle to those not interested in the welfare of the chinch-bugs. They looked quite panic-stricken, and moved about in a slow and dazed way, figuratively speaking, as if badly scared. And well they might be! The victims of the disease could be seen everywhere by the thousands; they had been slaughtered in all kinds of positions, but they were usually fastened to the blades and stems of the grass, or to the leaves of the young clover. All showed plainly that their last and strong determination in life had been to hold on as long as possible; their legs were firmly planted upon the substance where the bugs happened to be; others

had only their beaks inserted and were dangling by it free in the air. But all showed the characteristic white mycelium threads and spores of the disease. The illustration in Fig. 3 shows an enlarged chinch-bug, with white threads issuing from its body, and numerous other specimens in natural size killed by the fungus. Although almost exclusively attacking chinch-bugs, the disease was not slow in slaughtering such small flies as found the society of such malodorous companions to their taste. A story with a moral." "Most, if not all, the chinch-bugs would have been killed at the Experiment Station, if the suitable conditions for the disease had lasted a few days longer. But the wet spell which prevailed part of the time the disease was playing such havoc amongst the bugs soon passed and was followed by warm and very dry days, which soon stopped any further spread of the disease. But by artificially producing such conditions, the disease was kept at work for some time, but only on a very limited scale. Nor could it be spread, because in nature such artificial conditions could neither be produced nor maintained on any extensive scale. As many parts of the southern portion of this state were overrun with chinch-bugs, I thought that a good opportunity and an inviting field was presented to purposely spread a disease—an act not usually considered a very kind one to engage in, and one not to be recommended to physicians. This was exceedingly simple, as all that was necessary was to gather a number of the diseased bugs, put them in tight-fitting tin boxes and mail them to regions infested with chinch-bugs. Arrived at their destination, the contents of the boxes could be simply thrown in any field known to be infested with such bugs. This was done with specimens of the diseased bugs collected at the Experiment Station, and eighteen different places in Southern Minnesota were thus made centers of distribution for this disease. And, as it seems, with remarkably good results, as the disease has killed off the bugs to such an extent that careful search in a majority of places failed to produce a single living specimen, whilst the traces of the disease was found everywhere. The disease spread so rapidly that even corn growing near wheat-fields crowded with chinch-bugs was entirely protected, and no bugs had entered them in all the places visited by myself. But I am by no means satisfied that the disease was really introduced in this manner. Is it not possible that the disease was there already, unknown to anyone, and that I simply re-introduced its germs? The reason for this belief is based upon the fact that too large an area

was infested by the disease; too large to be readily accounted for by the short time in which the atmospheric conditions were—apparently—in its favor. But be this as it may; one thing is certain, viz.: The disease has been there, and consequently the spores of the fungus producing it are there also, and remain there, to act whenever the conditions are favorable; and I firmly believe that our farmers need not entertain any fears of chinch-bugs for the near future." The above statement was written late in the autumn of 1888, and subsequent events have shown that the belief then expressed became a fact. It might be added, that in the same autumn many thousands of circulars were mailed to farmers living in the region infested in that year with chinch-bugs. Several thousand replies were received, and by entering them upon a map of the state they clearly showed that for some reason or other the disease did execution only where introduced, and not in other places.

Besides the disease just mentioned, several others are found that are fatal to the chinch-bugs. One is a bacterial disease, thriving in the abdominal region of the bug. This disease seems to be less contagious than others, at least has as yet not given much promise that it might be utilized to destroy the insects upon a large scale. Bugs affected by it have usually a swollen abdomen, are weak and clumsy, so much so that if laid upon their back they are unable to reassume their proper position. After death the insects are not covered with a white dust composed of threads and spores, as is the case with other diseases caused by fungi.

The third fungus which causes the death of chinch-bugs is the White Fungas (*Sporotrichum globuliferum*). This fungus, though not strictly belonging to those that can only exist upon living insects, has been found to be the only one that can be manipulated with ease and success, as demonstrated again and again by the valuable and careful experiments made by Professors Snow, Forbes and others. Attacking by preference old and spent bugs, it will also attack healthy ones, in all stages of their growth, not even excepting the eggs. When conditions are favorable—i. e., when the bugs are weakened by wet weather—the increase of this fungus is exceedingly rapid and the disease caused by it sweeps over a large territory in a short time, killing the majority of the infesting army. The dried fungus can also be kept in tin boxes over winter, and is always ready to respond to our demands. As it matures its spores in a comparatively short time and in immense numbers, an artificial

increase may be very rapid. The disease caused by it would be a perfect remedy if all the conditions necessary to its spread in the infested fields could be controlled, which, however, is not possible. A bug infected by it shows symptoms similar to those attacked by the Entomophthora or Empusa already described. It becomes sluggish, does not like to move, changes somewhat in color, appears inflated, and is soon afterwards covered with an external white coat of fungus growth. This coat is so very dense that it hides more or less completely the dead host, thus differing greatly from the Entomophthora, where but comparatively few white threads are visible. Fig. 4 gives an idea of the appearance of this fungus enclosing a dead bug, while Fig. 3 shows that of the Entomophthora.

This short description of the three diseases now known to be fatal to chinch-bugs may suffice for the present time. Other diseases are also known, but they still require study and experiments to solve their history and habits. With these diseases we ought to be able to cope with the pest of our grain-fields, but at present we do not always succeed; nor can we expect to, simply because we cannot control the various necessary adjuncts to success, and consequently not too much confidence should be put upon any one of them. Future studies, experiments and experience may solve or lessen greatly the difficulties still in our path. Neither should we neglect to be always prepared; we should constantly be ready to utilize favorable climatic conditions and introduce such diseases, and should not wait for them to assist us, which they may or may not do. And as the spores of Sporotrichum can be kept for a long time without dying, can be increased both upon artificial cultures and upon the insects themselves, we should be failing in our duty to ourselves, to the community and to the whole state if we were not always ready to fight the enemy; in fact, an armed armistice should be the position held by us.

*Methods of increasing the number of diseased bugs* —Knowing the conditions under which fungi causing death to bugs thrive best, it is not very difficult to produce them artificially. We know that moisture and impaired health of the bugs are necessary. To produce the latter all that is necessary is to confine the more or less healthy bugs found in our fields to boxes made of wood—the infection boxes. Shutting off all the light, and forcing the bugs to exist in an atmosphere saturated with moisture, will give all the necessary conditions required by the fungus. If we take a shallow wooden box, six inches in depth, and not too large—say from three to four feet long and two feet wide—and cover the bottom with tightly pressed moist—not

wet—soil, we possess just what is needed. The bugs should, of course, be fed, and the sides of the box should be moistened from time to time, if it should become necessary. Chinch-bugs, loving the light, warmth and dryness, are not slow to be influenced by such unsuitable conditions as are prevailing in their prison, and soon become weaker in their vitality. If we now introduce a few diseased bugs, covered with the spores of the disease, the fungus causing it is surrounded by the necessary moisture and by bugs more or less weakened. The weaker ones, coming in contact with such spores during their anxious efforts to escape, will soon contract the disease, and after death become covered with a new crop of spores ready to further spread the disease. Many healthy bugs thus introduced into the infection box fail for a long time to contract the disease; in fact, we have sometimes raised a large number of young bugs to their pupal and even to their adult stage without having been able to make them diseased. But such cases are the exception and not the rule, as most of the bugs will before long show the effects of the infection, providing we have been careful to give the proper attention to the box. It is of course not necessary to introduce diseased bugs, as many persons seemed to think, as dead bugs are equally good, and better, being already covered with spores. Such an infection box will produce immense numbers of spores of the disease-giving fungi. The box should not be opened very often, since by doing so much of the moisture contained in the enclosed air will escape. A small sliding door in the top will facilitate the introduction of more prisoners. As soon as many bugs can be found that are covered with the fungus, they may be removed and other infection boxes can be started with them. When these boxes are working in a satisfactory way, most of the imprisoned bugs can be removed after two days and scattered in the fields infested with chinch-bugs. Those removed should be replaced with other bugs gathered in the field. In this manner everybody intending to utilize such diseases to fight the common enemy should be provided with an infection box in which he can produce all the spores he may require. It should be borne in mind, however, that cleanliness is here, as well as elsewhere, of great importance. The food provided for the still living bugs in the box, being surrounded by a moist atmosphere, so suitable for all kinds of molds, will soon decay, and therefore is apt to become moldy. This being the case, the food should be removed as soon as it is seen to commence to decay, as

decaying and rotting vegetable matter is sure to produce gases by no means of advantage to the fungi we are trying to produce. It is best to clean the boxes from time to time, because other enemies to our work will surely appear and give trouble. We should also not introduce too many bugs at the same time—not more than will fairly cover the surface of the soil. The infection boxes should be kept in the shade; if exposed to the hot rays of the sun we are apt to steam the prisoners, which, of course, will kill them, but not in the manner we wish to see them die. Nor should the boxes be kept in a cold cellar, as fungi of the kind desired require, besides moisture and weak bugs, sufficient warmth to develop rapidly. Perhaps it would be best to sink the whole box in a soil that is always well shaded. Of course many other methods will suggest themselves to the farmer, but he will do wisely to follow the directions here given, and not try to improve them, or even attempt to breed the disease in bottles, very wet inside, without containing food, tightly corked and exposed to the sun, as was done several times by some very smart persons who were furnished with diseased material. It is not simply dead bugs we wish to produce in the infection boxes, but diseased ones. Nor was it wise, in another case, to put the material received with the proper directions how to use it in a bottle that had contained castor-oil, or some other oil intended for a very different purpose. Many cases discovered last year showed that another "Comedy of Errors" might be written, based upon the manipulations of the chinch-bug diseases.

*Other Enemies Besides Diseases* —It is strange how soon people, even after having lost their entire crops of cereals in former years by chinch-bugs, forget the appearance of that insect. Not infrequently we have been told by farmers that knew all about this pest that the bugs measured over half an inch in length or had from ten to fifty legs. This forgetfulness is also clearly shown by the large number of specimens of all kinds of insects received at the Experiment Station with the query: "Are these chinch-bugs?" Some of these specimens have not the least resemblance to them, but are as widely different from the genuine article as a horse is from a hen. The illustrations given in Figs. 5 to 8 show insects that are frequently mistaken for chinch-bugs. Figs. 9 to 12 show useful insects, or such as make it part of their business to assist us against the enemy by devouring the same. Illustrations, Figs. 5 to 8, show insects that are frequently mistaken for the true chinch-bugs, and which, in

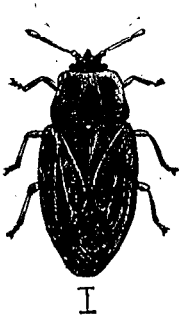


FIG. 5. Plesma. After Riley.

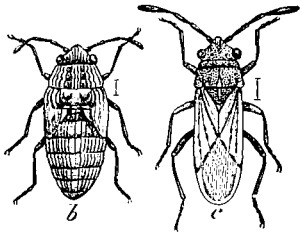


FIG. 7. False Chinch-Bug. After Riley.

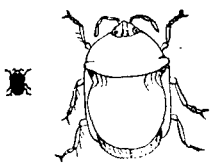


FIG. 6. Negro-Bug. After Riley.

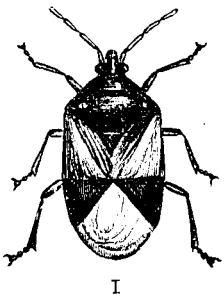


FIG. 8. Insidious Flower-Bug. After Riley.

consequence, have been frequently called "bogus chinch-bugs." These latter are by no means beneficial insects, yet they need not cause unnecessary alarm. The common names of all these insects are given below the illustrations. It seems that the chinch-bug occupies a position among insects shared by but few others—i. e., there is not a true parasitic insect that seems to enjoy the highly flavored bug.

When mentioning our friends among insects and other animals, we should not omit to state that many birds, reptiles, frogs and toads assist us materially against the enemy, and that we should protect our friends. It is a great shame that domineering man is so selfish! Birds like the Bob White and prairie chickens are killed on a large scale, simply because they are good to eat. But in pampering to our stomachs we forget that both birds, pressed by hunger during autumn, winter and early spring, make war upon the insects they may find hibernating. In fact, insects form the staple food for these birds, and consequently large numbers of chinch-bugs are

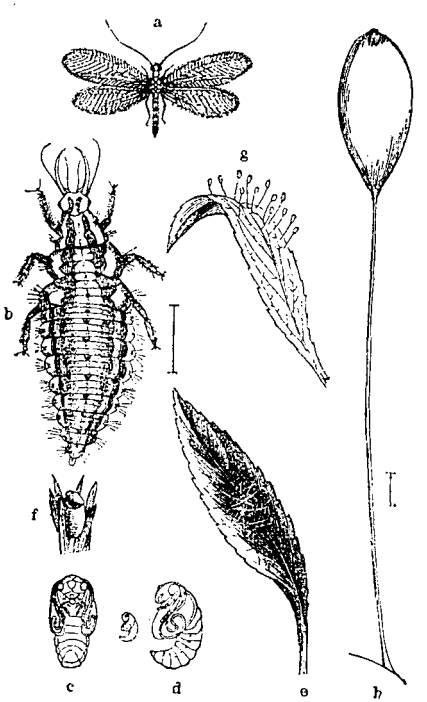
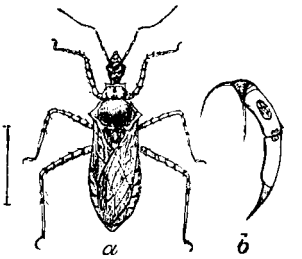



FIG. 10 Lace Wing.




Carnivorous Bug. After Riley.

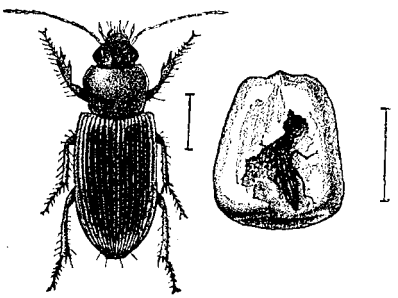


Fig. 11 Ground Beetle. From Div. of Entomology.

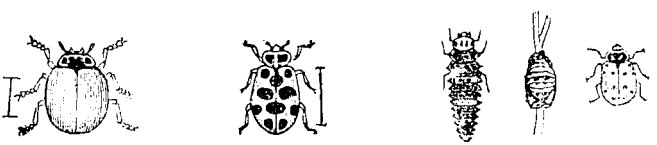


Fig. 12 Lady Bugs. From Div. of Entomology.

consumed. The red-winged blackbird, the cat bird, the brown thrush, the meadow lark, and several species of wrens, have been repeatedly observed to eat chinch-bugs, and even those of the above list that may appropriate some seeds and fruits not planted for them should be protected. Our domesticated fowls also eat chinch-bugs, but not all kinds and breeds act alike in this matter. Some chickens eat them greedily; others will not be tempted by them. The Guinea fowl and turkeys devour large numbers. Frogs and toads are also useful in chinch-bug years, and especially so the latter, which should always be protected.

*What was done in 1894.*—The climatic conditions which prevailed in 1894, and which were so highly favorable to chinch-bug increase, have already been mentioned. To illustrate them in a specific case, yet one not very different from the average condition that prevailed almost everywhere in Minnesota, the amount of rain and the temperature prevailing at Rochester is given in the following table, kindly prepared by Messrs. C. N. Ainslie and H. C. Butler, the former an ardent student of natural history and natural sciences:

1894.

| | MAY. | | | | JUNE. | | | | JULY. | | | | AUGUST. | | | | SEPTEMBER. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wind. | Rainfall. | Temp. | | Wind. | Rainfall. | Temp. | | Wind. | Rainfall. | Temp. | | Wind. | Rainfall. | Temp. | | Wind. | Rainfall. | Temp. |
| 1 | N.W. | 0.12 | 52 70 | 1 | N. | 0 | 42 78 | 1 | N.W. | 0 | 68-82 | 1 | N.W. | 0 | 66-82 | 1 | S. W. | 0 | 47-81 |
| 2 | S.E. | 0 | 36-61 | 2 | N. | 0 | 46 80 | 2 | N.W. | 0 | 50 82 | 2 | N.W. | 0 | 53 84 | 2 | S. W | 0 | 64-92 |
| 3 | S. | 0 | 48-58 | 3 | N.W. | 0 | 52-78 | 3 | N.W. | 0 | 52-80 | 3 | N.W. | 0 | 40-66 | 3 | S. W | 0.01 | 69-89 |
| 4 | S. | 0 | 36-68 | 4 | N.W. | 0 | 44-72 | 4 | N.W. | 0 | 52 74 | 4 | S. | 0 | 44-73 | 4 | N. E | 0 | 57-81 |
| 5 | S. | 2 04 | 48 68 | 5 | N. | 0 | 38 58 | 5 | N.W. | 0 | 46 80 | 5 | S. | 0 | 50-78 | 5 | S. | trace | 56 80 |
| 6 | W. | 0 | 48-58 | 6 | N.W. | 0 | 32 70 | 6 | N. | 0 | 56 72 | 6 | S. | 0 | 55-85 | 6 | S. | 0 | 61 85 |
| 7 | N.W. | 0 | 40-62 | 7 | N.W | 0 07 | 40 82 | 7 | N.W. | 0 | 42 78 | 7 | S. W. | trace | 59 87 | 7 | S.E. | 0 | 67 75 |
| 8 | N.W. | 0 | 38-72 | 8 | S. | 0 | 48 88 | 8 | W. | 0 | 48 86 | 8 | W. | 0 | 64-90 | 8 | S. W. | 0 | 56 81 |
| 9 | N.W. | 0 | 48-80 | 9 | S. | 0 | 58 84 | 9 | S. W. | 0 | 50-90 | 9 | N. | 0 | 60 97 | 9 | W. | 0 | 48-78 |
| 10 | N.W. | 0 | 48-56 | 10 | S. | 0 | 58 84 | 10 | S. W. | 0 | 56 90 | 10 | S. | 0 40 | 67-83 | 10 | N.W. | 0 | 44-80 |
| 11 | S. | 0 | 32 70 | 11 | S. | 0 | 60-90 | 11 | S. W. | 0 | 66 92 | 11 | S. | 0 | 64 85 | 11 | N.W. | 0 | 33-63 |
| 12 | S.E. | 0 | 48-80 | 12 | S. W. | 0 | 64 94 | 12 | S. W. | 0 | 70 92 | 12 | S. W. | 0 | 58-84 | 12 | S. | 0 | 37-68 |
| 13 | S.E. | 0 | 50-84 | 13 | S. W. | 0 | 64 96 | 13 | S. W. | 0 | 56-74 | 13 | S. W. | 0.15 | 58-83 | 13 | S.E. | 0 | 46-70 |
| 14 | S. W. | 0 | 64-84 | 14 | S. W. | 0 | 64 94 | 14 | W. | 0 | 50 80 | 14 | S. | 0 | 64 81 | 14 | S.E. | 0.25 | 52-71 |
| 15 | S. | 0.08 | 68-92 | 15 | S. W. | trace | 64 92 | 15 | N.W | 0 | 54-92 | 15 | S. W. | 0 | 53-82 | 15 | S. W. | 0 | 45 83 |
| 16 | S.E. | 0 | 62-82 | 16 | S. W. | 0 | 64 92 | 16 | W. | 0 | 60 94 | 16 | S.E. | 0 | 53-75 | 16 | W. | 0 | 49-71 |
| 17 | S.E. | 0 82 | 52 80 | 17 | N. E. | 0 | 72 68 | 17 | S. W. | 0 | 58-98 | 17 | S. | 0 | 57 83 | 17 | W. | 0 | 42-74 |
| 18 | N.W. | 0 | 36 50 | 18 | E. | 0 | 50-76 | 18 | S. | 0 | 64 98 | 18 | W. | 0 | 56-89 | 18 | W. | 0 | 28-64 |
| 19 | N.W. | 0 | 30-56 | 19 | S. E. | 0 | 52-78 | 19 | S. W | 0 | 68 94 | 19 | W. | 0 | 52-82 | 19 | S. E. | 0 | 48-72 |
| 20 | N. E. | 0 | 32 64 | 20 | S.E. | 0 | 66-90 | 20 | N.W. | 0 | 62 84 | 20 | S.E. | 0 | 59-85 | 20 | W. | 0 | 53-81 |
| 21 | E. | 0 | 40 58 | 21 | W. | 1.45 | 60-84 | 21 | W. | 0 | 46 86 | 21 | S. | 0 | 57-85 | 21 | N. E. | 0.66 | 47-66 |
| 22 | N. E. | trace | 46-56 | 22 | S. | 0 | 64 84 | 22 | S. W. | 0 | 54 92 | 22 | S. W. | 0 | 60-82 | 22 | S.E. | 0 | 47-75 |
| 23 | N. E. | 0 | 48 64 | 23 | S. E. | 0.78 | 64 78 | 23 | S. | 0 | 66-96 | 23 | W. | 0 | 65-88 | 23 | N.W. | 0 | 44-69 |
| 24 | N. E. | 0 | 50 70 | 24 | W. | 1 08 | 64 80 | 24 | N. | 0 | 66 88 | 24 | N. | 0 | 64-91 | 24 | W. | 0 | 35-55 |
| 25 | N.W. | 0 | 42-76 | 25 | S.E | 0 | 58 80 | 25 | S. | 0 | 52 92 | 25 | N. E. | 0 | 57 87 | 25 | S.E. | 0 | 35-54 |
| 26 | S. | 0 | 48-84 | 26 | S.E. | 0 | 56-86 | 26 | S. | 0 | 72 102 | 26 | N. E. | 0 | 50-84 | 26 | S.E. | 0 | 52-62 |
| 27 | N.W. | 0 | 42 56 | 27 | S.E. | 0 | 56 84 | 27 | N.W. | 0 | 77 102 | 27 | N.W. | 0 | 58-83 | 27 | S.E. | 0 | 50-76 |
| 28 | N. | 0 | 32-64 | 28 | W. | trace | 62-84 | 28 | N.W. | 0 | 71 96 | 28 | S. W. | 0 | 58-88 | 28 | S. W. | 0.26 | 59-83 |
| 29 | N W. | 0 | 46-70 | 29 | S. | 0 | 56-89 | 29 | W. | 0 | 51 84 | 29 | N.W. | 0 | 60 90 | 29 | S. W. | 0 | 62 84 |
| 30 | N. | 0 | 40 60 | 30 | S. E. | 0 | 66 92 | 30 | W. | 0 | 59-89 | 30 | W. | 0 | 47-77 | 30 | N.W. | 0 | 40-79 |
| 31 | N. | 0 | 36 68 | | | | | 31 | S. | 0.03 | 69-89 | 31 | W. | 0 | 46-76 | | | | |

Temperature figures furnished by Judge H. C. Butler, the others by Chas. N. Ainslie, both of Rochester, Minn.

Notwithstanding this almost unparalleled drouth, the crops of small grains were but little damaged, either by lack of moisture or by chinch-bugs; the ripening period of the plants was simply greatly shortened. Only in a few exceptional cases did crops suffer from both. Yet such favorable conditions must necessarily have vastly increased the number of chinch-bugs during that season, and the outlook for 1895 becomes gloomy indeed, if our fears should be realized. His Excellency, Governor Nelson, always willing to assist the

agricultural class of our citizens in such emergencies, and realizing fully the danger threatened by chinch-bugs, did all he possibly could by furnishing some means to start infection boxes. As there was no appropriation made for this important work, but a small sum of money could be expended, and not early enough in the season to fully test the value of the diseases discussed above. The County Commissioners of Olmsted, Blue Earth and Nicollet counties also assisted by appropriating some funds, and some of the owners of commercial mills helped all they could by furnishing help. Mr. Cole of Rochester and Mr. Hubbard of Mankato deserve the thanks of all farmers in their neighborhood for the interest taken in this work. A large amount of work was accomplished, and thousands of small tin boxes filled with diseased bugs were distributed to all farmers desiring them. A large number of reports showed that in many cases the disease worked well, even killing all the bugs infesting some fields. In many other cases the success was less apparent, and in still others none could be observed. Considering the phenomenally dry season, more could not be expected, and that in many fields the disease should have spread at all speaks well in favor of the white fungus disease, which was mainly employed.

Considerable harm has been caused by highly sensational articles in newspapers published during the last six or seven years, in regard to this method of killing chinch-bugs, which read as if the bugs could be killed by such diseases as if by magic, and this in a few days, or even hours. Nearly every farmer had read such articles, and many of the more uneducated ones based all expectations from the remedies applied by them upon such a disease instead of upon those dependent upon the habits of the insects—the only true remedies we possess at present. Many farmers actually expected that by throwing a pinch of the diseased bugs in a large field infested with bugs, these would—presto!—be found dead the next day. They did not realize that the introduction of a disease requires very careful work, and work that not every farmer can perform. To dispel any such illusions this bulletin has been prepared, and also to show how farmers must act to overcome the enemy. The results obtained by the experiments of last year are encouraging, yet no one should base all his hopes upon the introduction of such diseases alone, but should mainly depend upon the other remedies given, which are sufficient, if honestly and thoroughly applied. These latter can aways be depended upon, while the former may or may not

work, depending so much, as they do, upon conditions that cannot be controlled. Yet this does not mean that such experiments should be abandoned; on the contrary, they offer the only other hopes we possess of gaining the mastery over an insect like the chinch-bug. A private man cannot enter into these experiments, which are both expensive and tedious; but an agricultural state like Minnesota should always have the means ready to assist farmers if the opportunity offers. For this reason it is hoped that the legislature will see fit to appropriate a sufficient amount of money for investigations and experiments of this and similar character. "Forewarned is forearmed" is a proverb that should teach us a very valuable lesson.