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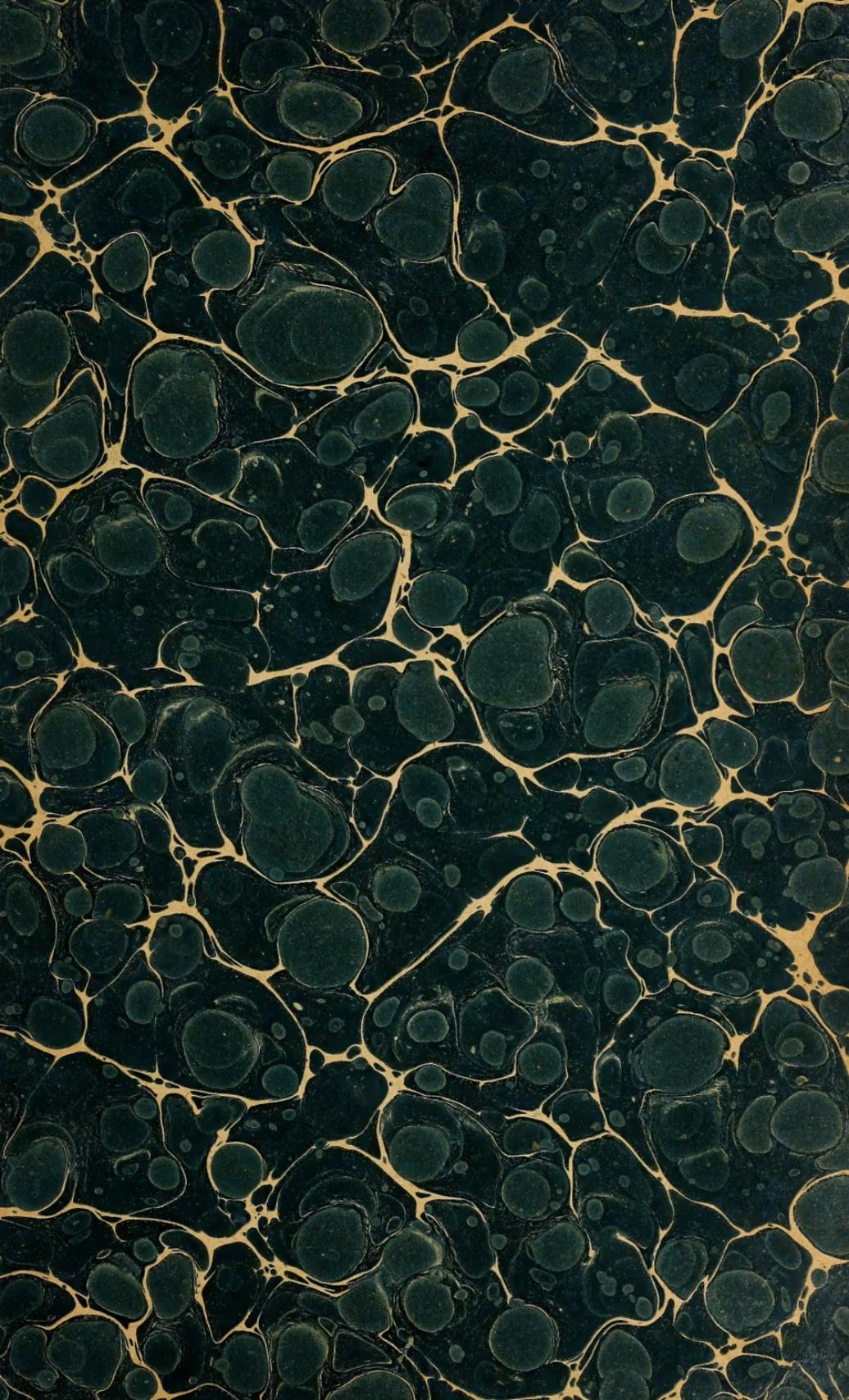
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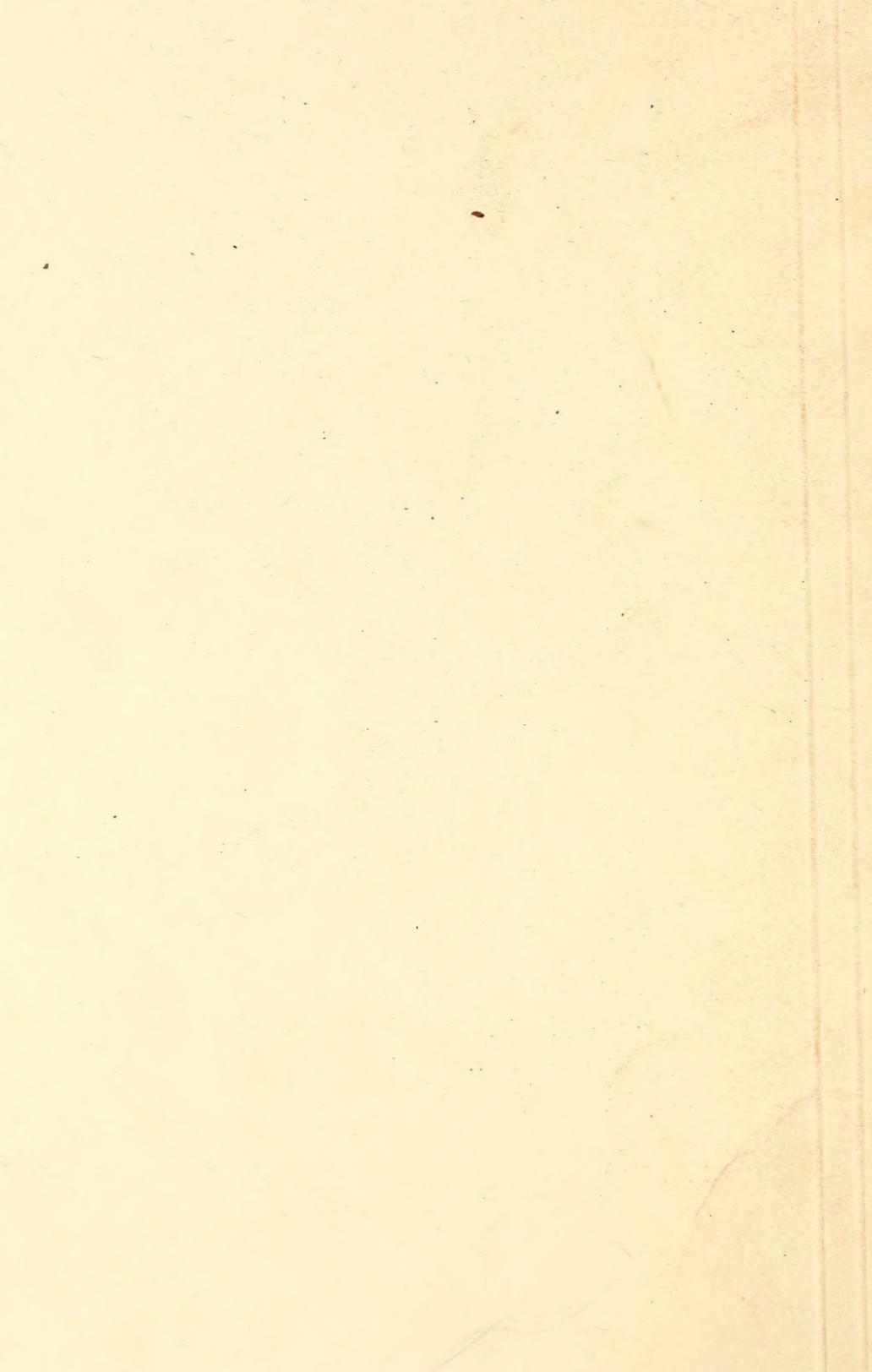
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United States Department of Agriculture,

BUREAU OF ENTOMOLOGY,

L. O. HOWARD, Entomologist and Chief of Bureau.

THE GRASSHOPPER PROBLEM AND ALFALFA CULTURE.

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SPECIES RESPONSIBLE FOR DEPREDACTIONS.

While specimens of the species of grasshoppers actually engaged in devastating alfalfa fields have not always accompanied complaints of their ravages, it is nevertheless possible, taking the data secured by Government and State officials in connection with information from correspondents, accompanied by specimens of the insects actually committing these depredations, to fix the responsibility—largely at least—upon two species. One of these is known as the differential grasshopper (*Melanoplus differentialis* Thos., fig. 1) and the other as the two-striped grasshopper (*Melanoplus bivittatus* Say., fig. 2).

Other species of grasshoppers have probably at times been more or less involved, as it is rarely that material submitted with a complaint of damages does not include more than one species; on the other hand, species depredating on other crops on the same farm or ranch are often submitted under the supposition that they are like those seen at work in alfalfa. A notable case in point is that of the yellow-winged or pellucid grasshopper (*Camnula pellucida* Scudd.), which, while very destructive to grain and grass crops, is said to work but little injury to alfalfa. However, as all grasshoppers likely to become involved in this or similar depredations have much the same habits and all are probably susceptible to the same treatment, the question of species is not one to interest the farmer particularly, beyond the matter of his ability to determine for himself which one is the worst pest and to apply his measures of suppression more especially with reference thereto.

THE MEASURES HEREIN DESCRIBED ARE APPLICABLE ALSO TO CLOVER CROPS.

While this circular is primarily for the benefit of the alfalfa grower, the measures of suppression recommended may be applied in the clover fields of the eastern section of this country with equally good results. Indeed, the two species here discussed are at times destructively abundant in the red-clover fields of the Middle West, and the writer has there used the "hopperdozer" to advantage.

EARLY DEPREDACTIONS.

With the rapid increase in the culture of alfalfa throughout the country west of the Mississippi River there has come the problem of protecting this crop from attacks of several species of grasshoppers or locusts. The reason for this state of affairs is not at all obscure, as in order to breed freely and in destructive numbers these grasshoppers require two conditions: First, an undisturbed soil for the protection of their eggs after these have been deposited, and, second, an early food supply for the young in spring. No other crop comes so near supplying these conditions to an ideal degree as does alfalfa.

Thus it is that the farmer in this section of the country has from the beginning of alfalfa culture been sorely beset by these pests, whose destructive hordes might even now be said to follow closely in the footprints of the reclamation engineer.

SERIOUSNESS OF INJURIES.

Hardly a season passes during which more or less serious outbreaks are not reported in different localities, and the aid of this Bureau is frequently invoked in destroying these grasshoppers or otherwise lessening their ravages. Thus during the year 1905 1 such outbreak was reported from California, 7 from Colorado, 1 from Idaho, 10 from Kansas, 3 from New Mexico, 2 from Utah, and 1 from Texas. It is in no wise likely that these numbers indicate more than a minor portion of the destructive outbreaks of these pests that actually occurred over this territory, and the seriousness of some of these outbreaks is indicated by the fact that as many as 12 complaints were received from a single locality. In fact, the probabilities are that, as this agricultural industry increases, the amount of injury inflicted by these insects will greatly increase in future unless measures are taken to control them.

DESCRIPTIONS OF THE TWO PRINCIPAL ALFALFA-AFFECTING SPECIES.

The differential grasshopper (fig. 1) is about $1\frac{1}{2}$ inches long, its wings expand about $2\frac{1}{2}$ inches, and it is of a general bright yellowish-green color. There is, however, a nearly black melanic form that does

not seem to differ otherwise from the normal. The head and thorax are olive-brown, and the front wings are of very much the same color, without other markings but with a brownish shade at the base; the hind wings are tinged with green; the hind thighs are bright yellow, especially below, with four black marks; the hind shanks are yellow, with black spines and a ring of the same color near the base.

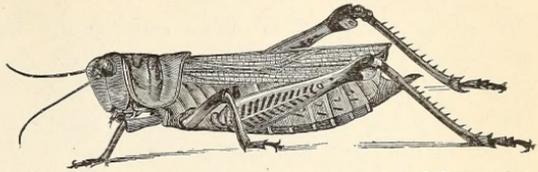


FIG. 1.—Differential grasshopper (*Melanoplus differentialis*). Natural size (after Riley).

The two-striped grasshopper (fig. 2) varies in color from a dull green to a dull brown, with a distinct yellow stripe extending on each side from the upper part of the eye to the end of the wing. The male is about $1\frac{1}{4}$ inches long and the female about one-fourth of an inch longer. This grasshopper may be so easily recognized from

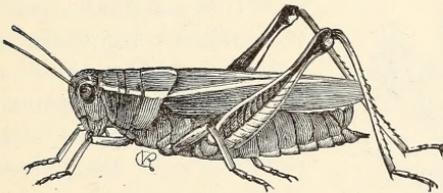


FIG. 2.—Two-striped grasshopper (*Melanoplus bivittatus*). Natural size (after Riley).

the accompanying figure that further description is unnecessary.

The young are very much like those of the Rocky Mountain grasshopper or locust (*Melanoplus spretus* Thos.), shown in figure 3.

DISTRIBUTION OF THE TWO SPECIES.

Although both these grasshoppers seem to be generally distributed over the country, the differential grasshopper rarely becomes destructively abundant east of the Mississippi River. It is very decidedly so, and with great frequency, however, to the west of the Mississippi, while, though extending from Maine to California, the two-striped grasshopper is sometimes disastrously abundant, locally at least, as far east as Ohio. In the red-clover-growing sections of the country the two-striped species is probably very much the more destructive of the two, though even as far east as Indiana the differential grasshopper does considerable injury to fruit trees by gnawing the bark from the twigs.

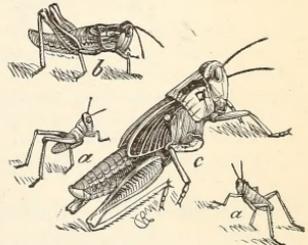


FIG. 3.—Rocky Mountain grasshopper or locust (*Melanoplus spretus*): a, a, newly hatched larvæ; b, full-grown larva; c, pupa. Natural size (after Riley).

LIFE HISTORIES AND HABITS.

The eggs are deposited in the ground in masses, inclosed in more or less kidney-shaped pods, in late summer and fall, after the manner

shown in figure 4, which illustrates the oviposition of the Rocky Mountain grasshopper or locust. The females seem to prefer a moderately compact, rather damp but not wet soil which is rarely disturbed by the plow or other cultivating implement. It will thus be seen that the alfalfa fields throughout the irrigated sections constitute an ideal breeding ground. Winter is passed in the egg state, the young hatching in spring and reaching maturity in summer, and there is but one annual generation. Neither of the two species is migratory. Their flight is rather clumsy, and they do not remain long on the wing before alighting.

NATURAL ENEMIES.

Upward of 100 species of birds are known to feed to a greater or less extent upon grasshoppers, but probably the most useful in this

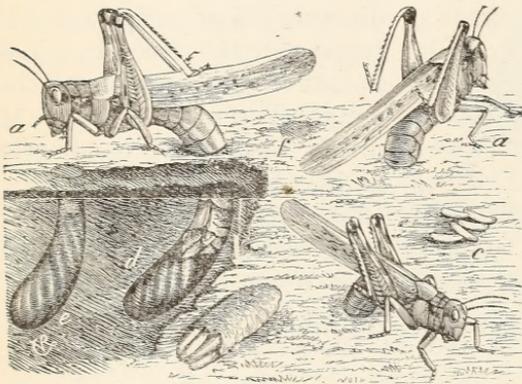


FIG. 4.—Rocky Mountain grasshopper or locust (*Melanoplus spretus*): a, a, female in different positions, ovipositing; b, egg-pod extracted from ground, with the end broken open; c, a few eggs lying loose on the ground; d, e show the earth partially removed, to illustrate an egg mass already in place and one being placed; f shows where such a mass has been covered up. (After Riley.)

direction are quails, prairie chickens, the sparrow hawk and Swainson hawk, the loggerhead shrike, all cuckoos, the cowbird, all blackbirds and meadowlarks, the catbird, and red-headed woodpecker. That domestic fowls are especially fond of these insects goes without saying. Skunks are very fond of grasshoppers, and are esteemed by the Bureau of Biological Survey as the most useful of mammals; they therefore deserve

protection rather than destruction by the farmer. Toads and probably some of the snakes add these insects to their bill of fare.

Of the insect enemies, the grasshopper mite (*Trombidium locustarum* Riley) is often found infesting grasshoppers in great numbers. It collects under the base of the wings, sometimes causing them to stand out from the body. While these mites probably destroy many grasshoppers, it is possible that their value to the farmer has been overestimated. There are several species of parasitic flies that frequently destroy immense numbers of these grasshoppers. Of these *Sarcophaga cimicis* Towns., *S. hunteri* Hough, and *S. georgina* Wied. (fig. 5) sometimes sweep these locusts off in myriads. Under date of August 7, 1906, Mr. John Hunton, of Fort Laramie, Wyo., forwarded to the Department a quantity of dead differential grasshoppers that he had found on different weeds and grasses over an

area of about 6 acres, mostly in alfalfa. He stated that although the live grasshoppers were yet very thick, many appeared weak and in a dying condition. When received the material was simply a mass of decaying bodies of grasshoppers and among them were both maggots and pupæ of *Sarcophaga georgina*. These flies deposit minute, elongated, ivory-white eggs on the surface of the bodies of the grasshoppers. The young maggots hatching from these make their way directly into the body of their host, and as they grow and develop there they feed upon the living insect. When full grown the maggots go into the ground and within a brown case transform to flies.

While all of these natural enemies do much to hold the pests in check, there are two or three vegetable parasites that also kill off myriads of them, the dead bodies of the grasshoppers destroyed thereby often being conspicuous objects as they cling to the weeds and grass where death overtook them (see fig. 6). One of these fungous parasites is the same as that attacking the chinch bug, and is known to science as *Sporotrichum globuliferum*. A group of grasshoppers that have been killed by this fungus is shown in figure 7.

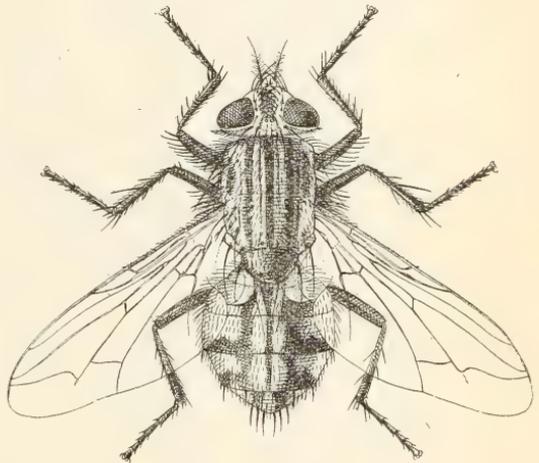


FIG. 5.—*Sarcophaga georgina*, a parasitic fly that destroys grasshoppers. Much enlarged (original).

While it will be seen that there is no lack of natural enemies of these grasshoppers, and while all of them are of benefit to the farmer, they do not and never will afford absolute protection from the ravages of these pests in the alfalfa fields. The reason for this is plain. By growing a single plant over large areas the farmer produces an unnatural condition and offers unnatural advantages for the development of the enemies of this plant, the grasshoppers. It is really the number of plants that invites insect attack. So, also, it is the great number of grasshoppers congregated together in masses that invites attack from natural enemies, and it is only when this condition is present that these natural enemies become sufficiently abundant to offer the farmer prompt and effective relief. In other words, the natural enemies, however much restraining force they may present, are always too far behind to wholly prevent occasional outbreaks of

these grasshoppers. The farmer, having undertaken the cultivation of alfalfa in large areas under conditions preeminently favorable for the development of grasshoppers, must now throw some restraining element into the other side of the scales in order to preserve the balance. It thus comes about that artificial repressive measures must be put into play in order to counteract, as it were, the effect on

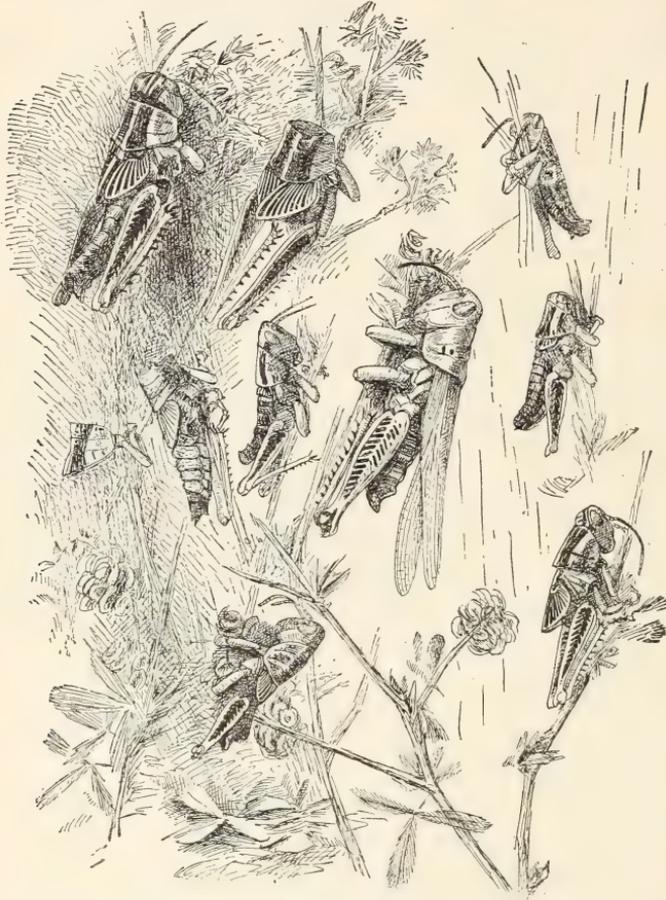


FIG. 6.—A view of grasshoppers dead and dying from fungous disease. Natural size. (From Howard.)

nature of a preponderance of alfalfa plants—a vastly greater number than would be produced under natural conditions. And this brings us to a consideration of preventive and repressive measures.

PREVENTIVE AND REMEDIAL MEASURES.

Preventive measures, as here restricted, apply to a period antedating the hatching of the young; while remedial measures are such as deal with the insects after hatching and with methods of destroying them.

While many modes of procedure have been advocated, tending to ward off impending attacks, and perhaps even a greater number of devices constructed and mixtures compounded for the destruction of grasshoppers, we will here consider only such as are readily and cheaply obtainable by the farmer and ranchman and those most practical in application.

DESTROYING THE EGGS.

Destroying the eggs of the grasshoppers seems to be the only preventive measure that promises to be worth while attempting, except, perhaps, the destruction of the young as they are hatching.

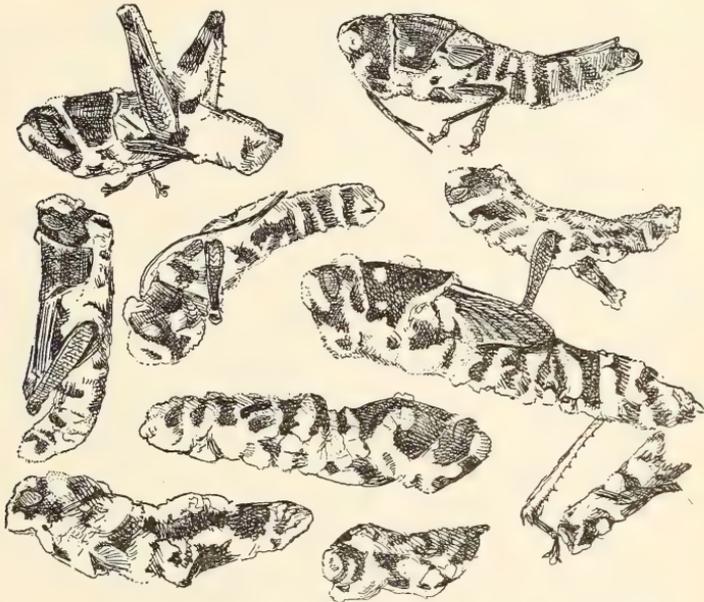


FIG. 7.—Grasshoppers killed by fungus, *Sporotrichum globuliferum*. (After Bruner.)

Destruction of the eggs may be accomplished by either plowing, harrowing, disking, or cultivating, in the fall or winter, all roadsides, ditch banks, margins of cultivated fields, uncultivated fields, and grassy margins along fences. In short, all waste lands that it is possible to reach in this manner should receive attention, unless it is known that no eggs were deposited there.

The soil need not be stirred deeply, 2 inches being a sufficient depth to accomplish the desired effect; and circumstances will probably dictate the kind of tool or tools that a farmer ought to use and where to use them. There is no doubt whatever that if this measure were put into operation at the proper time, in whatever manner is most practicable, disastrous outbreaks the following spring would be forestalled and prevented. Except in cases of isolated farms or

ranches, there should by all means be concerted action in this movement.

Where fields can be quickly inundated and the water promptly run off, as is frequently done in rice fields, the young grasshoppers may be killed by flooding the field for a day or two just as the eggs are hatching. If close watch is kept to determine just when the young grasshoppers are hatching, and prompt action taken at this time, much good can be accomplished; but as soon as the young begin to move about, flooding will avail but little, as the grasshoppers will climb to the upper part of vegetation beyond the reach of the water.

DESTROYING THE INSECTS.

Under this head will be discussed those measures which should be resorted to when the grasshoppers, having hatched from the egg, are threatening alfalfa fields from within or without, or both.

The hopperdozer.—On level or comparatively level land this implement can be used to good advantage in collecting grasshoppers of all ages—from the youngest to the adults. There are many modifications in the construction of these hopperdozers, but the form here described and figured, the writer has had made for him, and he has employed it in the fields and knows from experience that its use is both practicable and efficient. It is constructed of sheet iron, preferably galvanized, of reasonable thickness to insure strength, and, except for the end pieces, made of a single sheet 10 or 12 feet long and 26 inches in width. The front is formed by turning up one edge a couple of inches, and the back may be turned up a foot, thus making a shallow pan 1 foot wide, with the back the same height and with a front 2 inches high. Ends are riveted in and soldered, as shown in figure 8. Runners of old wagon tire are placed at each end (*a*, *b*), and another in the center (*e*) is turned over in the front and back to strengthen the pan at these points. These runners are riveted to the pan, as shown, and should extend both backward and forward in order to overcome to some extent the inequalities of the ground and cause the hopperdozer to run more smoothly. By soldering it about the heads of the rivets the pan will be made water-tight. The pan is filled with water on which is poured enough kerosene to cover it with a film, a horse is hitched to the end runners, and the outfit is then ready for use. As the hopperdozer is drawn over the ground the locusts will either jump into the kerosene and water direct or against the back and drop into it and there be killed. By using longer, wider, and heavier sheet iron a larger and stronger pan can be made and this further strengthened by additional runners; a horse can then be hitched to each end, or the pan may be mounted on low wheels. The whole thing is easily constructed, inexpensive, and once made may be put into service year after year as needed. The

only place where its use will prove more or less impracticable will be on hilly or rocky lands or on that not yet cleared of stumps.

Poisoned baits.—Here again we have an inexpensive, practical way of dealing with these grasshoppers even when, as is frequently the case, they breed in the alfalfa fields and the protection, whatever it may be, must be applied there. What has come to be known as the "Criddle mixture" is giving most satisfactory results on the ranches of both the United States and Canada. The mixture is composed of half a barrel of fresh horse droppings in which is mixed 1 pound each of salt and Paris green. If the horse droppings are not fresh the salt is dissolved in water and mixed with the manure and poison. When this mixture is scattered freely about where the grasshoppers are abundant they seem to be attracted to it, for they devour it readily and are poisoned thereby. Dr. James Fletcher, entomologist for the Dominion of Canada, cites an instance where

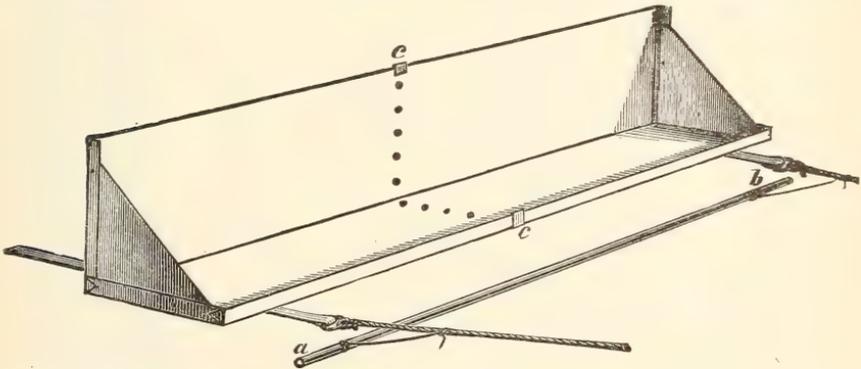


FIG. 8.—"Hopperdozer." A simple coal-oil pan, to be drawn by horse. (After Riley.)

this mixture had been scattered freely around the edges of a field and states that this particular field stood out as a green patch in a brown plain, as it was situated in the midst of fields where nothing had been done to destroy the grasshoppers. This Criddle mixture now seems preferable to the poisoned-bran remedy that has given and still continues to give beneficial results, for it is less expensive than the latter and less likely to poison other animal life.

COOPERATION.

Cooperation between farmers or ranchmen is of the utmost importance, whether the hopperdozer or poisoned baits be used. On some of the more extensive ranches the owners can protect themselves by reason of the great extent of territory that is under the control of a single individual, but among smaller holdings cooperation is very essential.

FORESTALLING OUTBREAKS.

The ranchman would style this "watching out for trouble." By this is meant the careful watching of the fields for the appearance of the grasshoppers. When these are found to be present, do not wait to see what they are going to do, but prevent their doing anything by putting into practice, before any damage has been done and while the grasshoppers are very young, whatever measures are to be used. It usually requires several days to poison the grasshoppers, and large areas can not be traversed with the hopperdozers in a day. Do not then wait to see what the grasshoppers will do, but see to it that by taking them at the start they are prevented from doing any harm.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *February 20, 1907.*

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