July 2017

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SOME INSECTS DESTRUCTIVE TO GRASS.

HERBERT OSBORN.

There is probably no greater loss from insects in the state of Iowa than that which occurs in meadows and pastures and while the loss is not so conspicuous as in some crops because of its insidious nature and the fact that it is only occasionally that the whole or a large part is taken, it is only necessary to note that the half or probably more of the growth of grasses is devoured by insects regularly to realize that there is here an enormous drain on this crop.

This loss becomes conspicuous in dry years or when the insects greatly multiply and it is generally believed that in such years some conditions favor the great multiplication of insects, but this is largely due to the fact that at such times their work becomes apparent, while in ordinary seasons the natural growth of the grass is able to keep up and the plants appear fresh in spite of the drain they sustain. It is easy to see, however, that they must support this horde of insects and if the insects were not there this would go to making hay or to feeding stock in pasture.

To the farmer the question will occur whether there is an actual constant loss of half or more of the growth of the grass crop in meadow and pasture and if so whether anything can be done to prevent or lessen the loss. I believe both questions are to be answered decidedly in the affirmative and I wish if possible to impress every one who reads these lines with this belief. Once fully appreciated, probably every farmer would be ready to attempt something toward saving the waste and would be willing to adopt simple and inexpensive methods of treatment.

Should anyone doubt the injury of insects in meadow and pastures let him take a walk in any piece of grass land and
observe carefully the kinds of insects to be seen and the numbers of each kind. First he will probably notice numerous small moths which fly up at his approach and dart away a rod or two to settle again. There are many species of these and sometimes so plentiful that a cloud will be disturbed at every step. Now these moths are the parent forms of numerous cut-worms and sod-worms that carry on a serious destruction at the surface of the ground or just beneath and must every year cause a vast amount of shrinkage in the crop.

Again the grasshoppers and crickets will attract attention especially in the latter part of the season when nearly grown, but the young grasshoppers will be observed almost every season in great numbers from June till they get their growth in fall and as they spring up on every hand, dozens of them on every square yard, it is only necessary to remember that each and every one has a voracious appetite and consumes, for its size, an immense amount of grass to realize that these alone must regularly devour nearly or quite as much grass as the cattle ordinarily pastured on the same land.

But let us look still more closely and without having to go into any but the nearest grass patch, we will find a swarm of small insects from an eighth to a half inch in length that rise close at our feet and are so plentiful that almost every blade of grass will have its occupant, at least during all the warmer months and some of them are quite plentiful even in late autumn, winter and early spring, and can be found at work on sunny days on such grass as keeps green through cold weather. These do not cut down and devour the grass but puncture and suck out the nutritious portions, leaving deadened spots and causing a wilted appearance in the grass.

In some estimates made in 1889 and published in Bulletin 22, Division of Entomology, U. S. Department Agriculture, I arrived at the conclusion that in ordinary years and when no exceptional damage would be noticed there could easily be 87,120 sod-worms, 50,000 grasshoppers and nearly a million leaf-hoppers on each acre of grass land, besides cut-worms, grub-worms and many other insects that occur in less number, but which in aggregate would cause much injury.
cluded that, at the very least, they could not devour less than the cattle ordinarily pastured on same land or to reverse it that by destroying these insects twice as many cattle could easily be pastured on the same area.

Can anything be done to prevent this loss? For many of the insects infesting pastures and meadows the application of remedies over large areas is difficult, but for the most of them we believe inexpensive measures will give very considerable relief. For the cut-worms, sod-worms, white-grubs and other species working under ground, a system of cropping and rotation is probably the most effectual method to suggest with our present knowledge of the insects, but for grasshoppers, leaf-hoppers and those insects which feed externally on the leaves, much can be done by the use of the hopper dozer, so extensively used for the Rocky Mountain Locust, and we believe that some form of this treatment may be applied at a very moderate cost so as to be entirely feasible in any pasture.

We hope to experiment in this direction the present season so as to be able to give more exact figures as to cost, but in the meantime would suggest the trial of one of the following plans by anyone having a convenient meadow or pasture that can be treated and results carefully watched.

The Hopper Dozer—Have made a sheet iron pan eight or ten feet long, eighteen inches wide and one or two inches deep in front and one foot deep behind. Put hooks at the ends to fasten ropes to and then arrange a stick or rope so as to drag about four to six inches in front of the pan. Put in enough water and kerosene, or coal tar to cover the bottom and keep it covered, and drag by hand, a man at each end or by horse, hitched to ropes a rod or more in front of the pan. The cost of pan should not exceed a dollar and a half to two dollars while the cost of kerosene or coal tar to keep a fresh supply in the pan as fast as it fills up with insects would be trifling, so that the expense is mainly that of running the pan and this, even if all help is hired, should not exceed ten cents per acre. At this rate a saving of even one-fourth or one-third of the crop would give a good return for the outlay, even if the application had to be repeated once or twice.

If it is noticed that the hoppers jump too quick and fall in
front of the pan, fasten the stick nearer the pan; if too late and they are run over by the pan, a little further in front. In short, adjust this so as to get the greatest number to drop directly into the liquid.

Another method and one which will perhaps be found more effectual and cheaper, is to make a light frame and stretch upon this a sheet of canvas or building paper. Place this upon runners or small wheels so that the frame will just clear the ground or if grass is tall so it will bend the stalks. Fasten it so that it will incline a little backward from the upright and keep it coated with soft coal tar or gas tar and run across the field at a rapid walk. The frame can be built ten to fifteen feet in length or as long as can be handled conveniently, the longer the better so far as capturing all the insects are concerned.

We would very much like to have these plans tried by parties in different parts of the state and a report upon the results sent in the latter part of the summer so we can use them in making up a report upon the methods of treating this class of insects.

There is not much probability that plowing under of grass would be of any advantage for the leaf hoppers, but where it is possible to burn the grass land over in the spring as when the dead grass is quite dry and will burn rapidly it is probable that a considerable amount of advantage will result from the destruction of such adults or eggs as may be present at the time.

In order that the leaf-hoppers that infest grass may be more readily known, descriptions of a few of the most common in grass will be given here with figures illustrating them.

**THE TENDERFOOT LEAF-HOPPER.**

*(Diedrocephala mollipes, Say.)*

This species often occurs in very great abundance, but I suspect favors moisture and hence is more abundant in pastures during seasons of ordinary rainfall, while in dry seasons when its work would be most noticeable it appears to collect more in low ground, marshy places and sloughs. It occurs all over the country and is said to be very common on the reedy
grasses of the salt marshes along the Atlantic coast. It is of a bright grass green color and easily escapes notice, but if disturbed it springs quickly into the air to settle again at a short distance. It is about a third of an inch long and its form and the larva (a) and pupa (b) are shown in the accompanying figure.

The larvae are most common in early summer, but all stages are to be observed together during the summer months. The adults have not been observed during late fall or in winter and it is possible that they lay eggs and then perish in autumn, the eggs surviving the winter to hatch in spring. It is a very active species and one which is easily caught in any trap of the hopper dozer plan.

THE HURTFUL LEAF-HOPPER.

(*Deltoccephalus inimicus*, Say.)

There is perhaps no species of grass insect of such universal distribution through the country and such uniform abundance every year as this. I have noted them in great abundance every month of the year from May till December. They persist in their attacks even after grass shows decided injury from their presence or is parched from drouth and I have no doubt that much of the wilting and withering of grass that is credited to lack of moisture, results from the fact that these little pests have sapped it of all the moisture it is able to draw from the soil.

The insect is nearly a fourth of an inch in length and of a grayish or yellow color, the most distinctive marks appearing to be the black dots on head, front portion of thorax and on the triangular piece behind, between base of wings, two on each, so that there are six dots arranged in pairs. These are shown in the figure (figure 2), as well as the form of the body, and the arrangement of dark markings on the
wings. It would be very exceptional if anyone in the state were to examine blue grass pasture or meadow, between May and late in the fall, and fail to find this insect.

The larvae are light yellowish, and fully as active as the adults, and jump readily, but are of course unable to fly. They appear in great numbers in May and June, and again in August and September, but as they are more or less abundant with the adults all through the season it is difficult to state the exact number of broods that occur each season.

*Deltocephalus debilis* Uhler.

It requires pretty close attention to see the difference between this species and the *D. inimicus*, but as they are distinct and, moreover, are not always found in abundance at the same times, and possibly differ slightly in their life histories, it seems important to state the points by which they may be distinguished. This species is smaller, more uniform in color, lacks the black dots mentioned for the other, and the wings, though often showing traces of dark spots along the veins, are never, so far as I have noticed, so distinctly marked with the blackish clouds or patches bordering the veins.

While perhaps less universally distributed I have found it at times to occur in marvelous abundance, so plentiful that hundreds would appear to arise from every square foot of ground when disturbed. Their larvae are doubtless confused with those of *inimicus*, as I have not as yet found means of clearly distinguishing them. Figure 3 shows the adult, the hair line at the side showing its actual length.

**THE DESTRUCTIVE LEAF-HOPPER.**

*(Cicadula exitiosa* Uhler.)

The first notice given to this insect was a little over ten years ago, when it was described as a wheat pest in some of the southern states. From its very common occurrence in grass in Iowa I am inclined to believe that, with us at any rate, it is to be considered a grass pest rather than a wheat
pest, though I have no doubt of its ability to cause great destruction in wheat fields when once present in them.

It is about two-tenths of an inch in length, of a brownish color, and the wings are quite distinctly marked with dark veins. The figure illustrates its general form and the arrangement of the markings on the dorsal surface. Its length is shown by the hair line at the side.

OTHER SPECIES.

There are a number of other species that occur in grass, some of them at times very numerous, but they have much the same habits as those mentioned, and require, so far as we know yet, similar treatment. We hope, however, to be able to give fuller account of them at another time.

THE CLOVER SEED MIDGE.

(Cecidomyia leguminicola, Lintner.)

HERBERT OSBORN and H. A. GOSSARD.

This insect, well known for a number of years in the east as a serious clover pest, has now reached a position to demand the serious attention of the farmers of Iowa.

It was first observed at Ames in 1888, when a very few adults were reared from clover heads, which had been kept in closed tubes for the study of other insects. The next season it was more plentiful, and since then reports indicate that it has become abundant in many parts of the state, and threatens the clover seed crop to a serious extent.

The attention of Prof. J. A. Lintner was turned to the insect in 1877. He was shown some heads of Red Clover which contained some dipterous larvae feeding on the seeds. In 1878, in his report of some of the injurious insects of the year, to the New York State Agricultural Society, he briefly described the larva and named it the Cecidomyia trifolii, a name which he changed to C. leguminicola on learning that the first name had already been bestowed by Loew on a European species.
Prof. Riley also observed the insect in 1878, and in the Annual Report of the Department of Agriculture for that year contributed to its natural history, and also illustrated it in its different stages.

The ravages of this insect have been most serious in New York, where it made its first appearance, but other localities have suffered severely, and its distribution at present extends as far west as Iowa, north into Canada, and south into Virginia.

Prof. Forbes observed it in Illinois as early as 1879, but it has not portended serious danger to the clover crop of this section until recently.

In addition to feeding upon the seed of red clover (Trifolium pratense), the larvae have been observed destroying the seed of the common white clover (T. repens), but we find no record of its feeding upon Alsike clover (T. hybridum).

The following facts and observations in the history of the midge and its parasites have been drawn chiefly from the works of Riley, Lintner, and Comstock, as indicated in connection with each paragraph. We believe it of too much importance to the agriculture of Iowa to wait till personal studies have been made in this state before publishing information regarding it.

"During the month of September the midges were observed copulating and the females afterward laying their eggs. The eggs are so small that it is almost impossible to see them with the naked eye. Their average length is .27 mm (.01 inch). They are long oval in shape, their length being three times their breadth, and one end is slightly larger than the other. The general color is pale yellow, and an orange streak is more or less evident, according to the age of the embryo.

The female in depositing her eggs simply pushes them down between the hairs which surround the seed capsule of the yet undeveloped florets. They do not appear to be glued to the hairs nor are they inserted into the skin of the capsule, and I have never seen them pushed into the closed florets. After the larvae hatch, they have to work their way to the seed through the mouth of the flower. The eggs are usually
laid singly, but are often found in clusters of from two to five. In one flower head I have counted over fifty eggs.

**The Larva**—The specimens of the seed maggots received from Yates county, N. Y., were bright orange red in color, while those found this spring (1879) in Washington were nearly white, occasionally with a tinge of pinkish. Specimens received about the middle of the summer from Otsego and Schoharie counties, N. Y., were also nearly white in color, while specimens from Yates county had still stronger orange tinge.

As stated in the report for 1878, the full grown larvae leave the clover heads and fall to the ground where they form for themselves small cocoons. As they leave the heads of clover, the sight is an interesting one. A head, which one moment is motionless, and at a glance seems to have no animal life about it, becomes the next, fairly swarming with these maggots. From nearly every closed floret one emerges and wriggles violently, until it works its ways so far that it falls to the ground. A patch of clover upon the Department grounds which was observed by Mr. Howard on the morning of May 23, seemed entirely alive with the issuing maggots and their accompanying parasitic foes.

**Pupa**—The pupa is pale orange in color with brown eyes. On the front of the head are two short conical tubercles, and behind them two long bristles. The leg sheaths reach nearly to the end of the abdomen, the wing pads to the fourth abdominal segment, and the antennal sheaths to the first abdominal segment. From each side of the mesothorax, just anterior and ventral to the insertion of the wings, projects a rather long excurved horn.

After the fly has emerged, if the pupal skin be examined, the antennal sheaths will be found curved out like the handles to an urn, giving it a peculiar appearance. The duration of the pupal state of the early brood is about ten days. (Comstock.)

In the accompanying figures for which we are indebted to Dr. C. V. Riley, figure 5, a, represents enlarged dorsal view of female with scales denuded; b, head; c, genitalia; d, antennal joints more highly magnified to show structure; e, tarsal claw; f, forms of scales.
Figure 6, a, enlarged side view of male with scales denuded to show more clearly the structure; b, more highly magnified, to show structure of the eye, palpi, and basal joints of the antennal; c, tip of ovipositor highly magnified, and showing at end of penultimate joint the manner in which it is clothed with minute hairs; d, highly magnified antennal joints, their minute hairy clothing shown on the lower one.

Figure 7, a, larva enlarged, ventral view; b, head retracted and more highly magnified.

Prof. Comstock states that the midges vary to a greater or less extent in size, color, and markings. Some are much smaller, and paler in color than others. The males, in which the variation...
is most noticeable, have a double row of transverse dark spots on the dorsum of the abdomen. These spots are in some individuals almost entirely absent and in others they vary much in size and distinctness. On the ventral side of the abdomen there is also a central row of irregularly shaped dark spots, in which there is also much variation.

According to Lintner, there are two annual broods and in seasons unusually favorable for their development, perhaps three broods in the state of New York. He states that the flies begin making their appearance in the latter part of May; that these adults deposit the eggs from which the first brood issues about the middle of July; that these again ovipositing should produce the second brood as early as September 25, and that only a portion of the brood emerge from their pupæ in the autumn, the remainder hibernating among the roots of the clover. It is from these hibernating individuals that we have the flies which emerge during the first part of May to deposit their eggs as before stated, in the forming clover heads for the summer brood. (Lintner.)

The observations of the Department at Washington would indicate three broods as the rule in that latitude. The full grown larvæ of the first brood were found going into the ground in great numbers on the 23d of May. The first flies issued on June 7, and early in September they were again issuing in larger numbers. (Annual Report, 1879.)

Parasites—Two parasites have been described for this insect and have doubtless done much to keep it in check.

The first of these is a minute wasp-like insect belonging to the same family as the joint-worm fly (Insosoma hordei Harr.) and has been described by Dr. Howard as Eurytoma funebris. The first specimens of this parasite were found upon the 3d of May and were very abundant until June. They of course attack the first brood of the midge. They undergo their transformations within the seed, and as flies gnaw an irregular hole through the seed vessel just large enough to let them out at or shortly after the time when the maggots have left the seed to go into the ground. An examination made on the 20th of June showed the fact that on an average five-sixths of the seed had been destroyed by the midges, and that four-
fifths of the midges had been destroyed by this parasite. The prospective second brood of the midge was therefore reduced eighty per cent. by the work of this little Chalcid.

The second parasite has been bred from New York specimens of the midge. It belongs to the family Proctotrupidæ and was described by Dr. Fitch as Platygaster error. He obtained specimens in wheat fields but did not actually indicate the insect which they parasitized. This parasite is described as jet black, with the exception that the anterior tarsi and tips of tibiae are light brown, while the posterior and middle tarsi are darker. This species develops so slowly that the larva of the midge has time to drop to the ground and develop into the pupa before it is finally destroyed. The full grown parasite cuts its way through the cocoon and escapes from the ground.

Remedial Agencies—With regard to the remedial measures that can be applied to the insect there seems to have been no suggestion of much importance since those made when the insect was first studied. The first is the turning under deeply of the infected fields while the larvae are the most abundant and cessation of clover culture for a period of time. Second, to cut the clover two or three weeks earlier than the usual time, say in early June, or as soon as clover fields are in full bloom, so that the first brood of maggots will not have time to develop. The latter seems much to be preferred as it gives an opportunity for two cuttings of the clover, the second in the autumn, so that the crop of hay would be but slightly reduced, and the midge practically destroyed. Care should be taken, however, that any clover growing wild in fence corners and elsewhere, that could afford harbor for the midges, be cut down, and the more nearly the farmers of a given locality agree upon an early uniform time of cutting, the more satisfactory will be the results.

In case it is desired to plow under the clover and plant some other crop it would seem that the best time for this purpose would be at the time of clover bloom for the second crop when the greatest number of maggots of the second brood would be turned under and destroyed.
THE HORN-FLY.

(\textit{Hæmatobia serrata} Robineau-Desvoidy.)

HERBERT OSBORN.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig8}
\caption{\textit{Hæmatobia serrata}: a, egg; b, larva; c, puparium; d, adult in biting position—all enlarged. (After Riley and Howard).}
\end{figure}

This insect was introduced into the eastern states from Europe only four or five years ago, but has proven very troublesome in a number of localities, especially in Maryland, New Jersey and other Atlantic states, and is becoming distributed throughout the country. It will doubtless appear in this state in the near future, though at present writing, except for one uncertain statement as to its appearance in the southeast part of the state, I have seen no report of its occurrence in Iowa.

While a native of Europe, it does not appear to have had as careful investigation there as it has had in this country. The Division of Entomology of the United States Department of Agriculture made it a subject of special investigation and a very complete account is given in Insect Life, Vol. II, p. 93. It is to this account that we are indebted for the facts
here given and to the kindness of Prof. Riley for the use of the figure with which to illustrate the different stages. We believe that it is important that the stock breeders and dairy-men of the state should be ready to recognize this insect on its first appearance in the state, and offer no apology for presenting the matter here in advance of the actual recognition of the insect in the state.

The common name of Horn-Fly is given on account of the habit the insect has of collecting on the horns, but it should be remembered that the insects merely cluster here while resting and that they injure or molest the animal by puncturing the skin and sucking the blood at other points on the body. The eggs are deposited in freshly dropped cow manure and mainly during the warm hours of the day. The larvae on hatching bury themselves in the dung to feed and grow, but remain near the surface. When ready to transform they evidently descend from the dung into the ground and bury themselves from a half inch to three-quarters of an inch if the earth is soft. The period of development for the insect from eggs to adult form is from ten to seventeen days and it is estimated that there may be as many as eight generations during the time when the insects occur (May 15 till September 15 or later).

The flies (Figure 8, d, adult male) are scarcely a fourth of an inch in length and have the general appearance of small house flies. It is this form only that the insect is troublesome to stock. They cluster on the cattle, especially around the base of the horns, but if not very abundant and at all times while feeding upon the blood of their victims, they are scattered over different parts of the body, and particularly along the back.

The amount of damage is considered as overestimated by some and underestimated by others. It consists not only in loss of blood, but in the irritation which their presence occasions.

With regard to remedial measures we quote directly from the article already mentioned.

Applications to Destroy the Fly.—A great deal has been said during the summer concerning the merits of a proprietary substance, consisting mainly of tobacco dust and creo-
sote, known as “X. O. Dust,” and manufactured by a Balti­more firm, as an applicatine to cattle, and it has received an indorsement from Prof. J. B. Smith, Entomologist to the New Jersey Experiment Station. We are convinced that this substance has considerable merit as an insecticide, and know from experience that it will kill many of the flies when it touches them, although they die slowly, and a few may recover. The substance costs 25 cents per pound, and is not lasting in its effects. Where it is dusted through the hair the flies on alighting will not remain long enough to bite, but two days later, according to our experience, they are again present in as great numbers as before. A spray of kerosene emulsion directed upon a cow would kill the flies quite as surely, and would be cheaper, but we do not advise an attempt to reduce the numbers of the pest by actually killing the flies.

*How to Destroy the Early Stages.*—Throwing a spadeful of lime upon a cow dung will destroy the larvæ which are living in it, and as in almost every pasture there are some one or two spots where the cattle preferably congregate during the heat of the day, the dung which contains most of the larvæ will consequently be more or less together and easy to treat at once. If the evil should increase therefore, it will well pay a stock raiser to start a load of lime through his field occasionally, particularly in May or June, as every larva killed then represents the death of very many flies during August. We feel certain that this course will be found in many cases practical and of great avail and will often be of an advantage to the pasture besides.”

THE APPLE MAGGOT.

(*Trypeta pomonella*, Walsh.)

HERBERT OSBORN.

While this insect has for the most part been confined to states east of us in its serious depredations, the many reports of its damage during the past season in certain points in Iowa indicates that our fruit growers should be on their guard.
against it. While it has not been made a subject of special investigation here, it seems very important that information be given as to its habits and the measures that can be used to prevent its introduction and spread in the state.

The following condensed statement is taken largely from a very complete account of the insect by Prof. F. L. Harvey, an early graduate of the Iowa Agricultural College, and at present in charge of the Botany and Entomology of the Maine State College and Experiment Station. We are indebted to Prof. Harvey for the opportunity to use the figures which accompany this paper.

Trypeta pomonella: 3, puncture where egg is laid, enlarged; 4, point from which worm escapes, enlarged; 5 and 6, burrows of worms in apple. (After Harvey).
The flies that deposit the eggs from which the maggots are developed appear in June and from that time on till late in fall. The eggs are deposited by puncturing the skin of the fruit, the puncture being shown highly magnified in Figure 9, 3. The eggs are deposited in all parts of the apple, but most commonly upon the cheeks and less on the calyx and stem ends. They hatch in four or five days and the maggots begin at once to work in the pulp of the fruit, and as they grow fill it full of channels and burrows (Fig. 9, 6) and as these are extended they coalesce and reduce the pulp to a series of cavities (Fig. 9, 5). This work does not show on the outside perceptibly and the fruit may be shipped as good, but soon rots and gives up its horde of larvae. Figure 9, 4 shows the opening made in emerging from the apple magnified and Figure 3, Plate I illustrates the full grown larva.

These enter the ground to become pupae (Fig. 10) and in this stage the insect remains over winter to emerge the following season sometime between May and autumn. The adults are shown in Figures 1 (female) and 2 (male), Plate I.

The remedies most strongly recommended are the immediate destruction of the windfalls in infested orchards which can be done by gathering them every day and feeding them to swine or throwing them in pits that should be covered with a foot or two of earth after the season is over. Or, where it can be done, hogs or sheep may be allowed to range for a time each day in the orchard to gather up the windfalls, and if enough to collect them thoroughly this would be the most feasible plan.

A matter requiring special attention here is to prevent their introduction from other localities and particularly states farther south from which we get a large supply of early apples.

(http://lib.dr.iastate.edu/bulletin/vol2/iss13/4 (After Harvey.)
In some instances reported to me there was very evidently an introduction from Missouri, and it seems important that our apple market should be watched carefully and any introduction of infested fruit reported at once and every means taken to prevent the spread of the insects. It may be necessary to secure legislation providing for the condemnation and destruction of infested fruit and it would devolve upon home fruit growers to watch each one his own market in order to protect his orchards from the pest.

I would suggest that for the present season every fruit grower keep a particular watch for this insect, and if finding fruit that shows any evidence of the maggots, to make a careful examination or send at once samples of the suspected fruit to the Experiment Station, so that it may be examined.

At the end of the season or at any other time, I would be glad to hear from as many fruit growers as possible as to the presence or absence of apple maggots in their localities for the season. In this way we can determine how great a danger there may be from the insect and whether there is need of special legislation against it.

**SPRAYING FOR ORCHARD INSECTS.**

This subject has been very fully treated in previous bulletins by Prof. Gillette, and extensively in Agricultural and Horticultural journals, by a great number of writers. A number of applications for information on this matter have, however, been received, and it seems proper to reproduce a condensed note on the subject, published in the Iowa Homestead.

There is no question as to the benefit to be derived from this method of fighting the Codling Moth, and it is applicable to trees of any size, even to the largest, but for very large trees of course the treatment must be adjusted to reach the topmost branches, and the spraying continued till all parts of the tree are reached.

**THE APPARATUS NECESSARY**

Is a good strong force pump, provided with a spraying nozzle and arranged to draw from a barrel or other receptacle, in which the poisonous solution is kept. There are a number
of valuable pumps on the market, and it will be well to ex­amine the catalogues of the Nixon Nozzle and Machine Com­pany, of Dayton, Ohio, the Field Force Pump Company, of Lockport, N. Y., the Ramsey Manufacturing Company, of Seneca Falls, N. Y., or of others that you know to be reliable, and select a machine to suit your purpose. It may be said here, however, that while it is convenient to have a pump that is geared to a wagon, or is adapted to pumping by horse power, there is the disadvantage of having to keep the team in motion, and it is not so easy to make sure of the thorough treatment of every tree as where the machine is simply drawn from tree to tree by horse power and the pumping done by hand. If the pump does not throw the spray to the top of the higher trees the nozzle may be held at the end of a bamboo rod the rubber tube being lengthened for this purpose.

Nozzles are sold with the machines, both of the companies first named manufacture good ones. The Cyclone Nozzle, which possesses many superior advantages, is manufactured by Thomas Somerville & Sons, 316 Thirteenth street, Wash­ington, D. C.

THE SOLUTIONS TO BE USED

Are London Purple or Paris Green, thoroughly stirred in water, using for London Purple one pound of the poison to every 200 gallons of water, and for Paris Green one pound for every 150 gallons of water. Care should be taken not to make the solutions stronger, and also to keep the solutions well agitated, as if applied stronger than the above mixtures there is danger of injuring the foliage. In some of the ma­chines made there is a special appliance for keeping the fluid agitated, but if not, this should be done with a stick, by hand, or the jet from the nozzle may occasionally be di­rected into the solution, if in an open barrel. Of the two poisons London Purple is the cheaper, remains better in sus­pension and is generally very effective. In some compara­tive tests, however, various experimentors have secured more reliable results with Paris Green.

WHEN TO APPLY.

For the Codling Moth or Apple Worm the application should be made soon after the dropping of the blossoms, never before, and it is a good plan to make a second applica­tion a week or ten days after the first one. Applications may, however, be made any time after bloom and before the apples begin to hang calyx end down, with expectation of getting valuable results.