The Codling Moth Manual

By **AUGUSTUS S. HARRIS**
Hope, New Mexico

21

THE CODLING MOTH MANUAL

SB945
.C7 H3

Copyright 1913

—by—

Augustus S. Harris

#.75-

©Cl.A345582

no 1

INTRODUCTION:

My object in presenting this little treatise to all those who are interested in apple culture, is to show by what means the apple worm and kindred pests may not only be controlled, but actually exterminated.

And, in the second place, to avoid the accumulation of poisonous substances in large quantities on the premises and the heavy expense necessarily incident to the present practice of spraying, as the only remedy to combat the codling moth.

Also to point out how, by the use of cheap natural and efficient means, within the reach of rich and poor alike, this terror of the apple grower, the apple worm, may be entirely overcome.

I have indulged in comments on the origin, nativity and especially the habits of the codling

moth, as all these, and principally the latter, are necessary to be understood.

The various remedies that the apple-grower has, from time to time, invented to oust the pest have been carefully considered, with the view of discovering their advantages and disadvantages.

AUGUSTUS S. HARRIS.

Hope, New Mexico, 1912.

CHAPTER I.

Losses Caused by the Worm.

It may be truthfully said that the arch enemy of the apple-grower is the codling moth, or apple worm. It stands directly in the passage way of the horticulturist, and must be made to stand aside before he can enter the clear fields of profit and prosperity, to which his vocation naturally entitles him.

The losses resulting from the annual deprecations of the apple worm mount into millions of dollars and call aloud for more efficient remedies than have as yet been employed. Remedies, not of partial control or diminution, but of utter extermination. Nothing short of this will put the apple-grower on the high road to prosperity. This effected, the way is easy and the road is his if he so wills it.

From the nature of the case, the losses can be approximated only. Quoting Farmers' Bulletin No. 247, U. S. Department of Agriculture: "It has been shown by careful estimates in various apple growing states that this insect may cause a loss of from 20 to 40 per cent of the fruit which

would otherwise be sound and merchantable. Without going into details, this loss on the lowest, or 20 per cent, basis amounts annually to \$11,400,000 in the United States. And this does not include the expenditures for spraying trees with arsenicals, which amount to more than 8,000,000 additional, indicating a loss chargeable to the codling moth of nearly \$20,000,000." The bulletin from which the above is quoted was published in 1906, and, of course, is applicable to conditions as they existed at that time. But the lapse of six years has brought about changed conditions. Vast areas of new apple bearing orchards have been added to the old. As the ravages of the worm have not been materially checked, except in certain localities; and as the cost of spraying now is about the same per acre as in 1906, it may be safely affirmed that the annual losses from the ravages of this insect are heavier now than in any other period of its history in the United States. Possibly thirty-five or forty million dollars is not too high an estimate. True economy, however, teaches that we should not lose a dollar on account of this or any other insect. And it is my purpose to show you how you may well-nigh compass this end.

There are other items that may be classed

under the head of losses. Many apple-growers, in their long, fruitless and expensive contest with this enemy, become discouraged and sell their orchard lands at a sacrifice. Others, warned by this experience, are deterred from engaging in the business.

Apple buyers become shy. Many carloads of apples have been sold at a reduced price on the discovery of one or two worm-infected apples.

CHAPTER II.

Nativity and Origin of the Apple Worm.

Pomologists tell us that the apple worm is a native of Southeast Europe, and that it was shipped from Europe to America some time in the early part of the last century. How, and in what form, it was imported to our continent is of no interest.

But as all animal life has a beginning, much practical interest is attached to the causes which, in the first instance, gave it being. For, once in possession of this knowledge, and the worm extirpated, its appearance could be prevented by avoiding that state of things that produced its origin. Observing the codling moth's successive steps of evolution, we are confident that the first moth did not lay the first egg. But that the first egg evolved into the first moth is highly probable, if not certain. Under normal conditions, it is the law of nature that the lower forms of life ascend into the higher, but never do the higher descend into the lower. Assuming the fact as settled that the first moth originated from an egg, what were the causes or combination of

causes that produced the egg? Surely, whatever produced the egg then will produce it now. It must be confessed that all answers to this question are theoretical. Yet, some theories are plausible, some probable, and some correct. Time will not be wasted in theorizing on this subject. We will premise that a state of absolute cleanliness is necessary to the perfect development of all the higher forms of animal life, and this too without a single exception. On the other hand, filth is necessary to the full development of all the lowest forms of animal life, such as grubs, lice, maggots, and the like. It is an axiom that filth breeds vermin. The writer is firm in his belief that the apple worm originated in some old, decayed and neglected orchard of the Eastern world. So, the apple worm once exterminated, in order to prevent its reappearance, the orchard must be kept in a clean, healthy and flourishing condition. It must be remembered, however, that although these low forms of life flourish most in filth, they will readily and ravenously assail any healthy form of life with which they come in contact, provided, this healthy form is of the same nature as that on which they are adapted to feed, and from which, in the diseased state, they took their origin.

CHAPTER III.

The Egg.

We shall consider the egg, as the first in the several phases of the codling moth. According to Mr. Saunders, a single moth lays about fifty eggs. According to Prof. L. H. Bailey, "A single egg is laid in the blossom end of the young apple." This is the first deposit in the early spring. Farmers' Bulletin No. 247 says: "The moth lays her eggs a few days after emergence on leaves of apple or other food plant, or on the fruit. A majority of the eggs of the first generation are laid on the leaves, while the greater part of those of the second generation are laid upon the fruit." A slight discrepancy in these authorities, as to the first laying, but not at all material, for whether laid on leaf or blossom, the same deleterious results soon follow. The bulletin goes on to say: "The eggs are very minute, scarcely visible to the naked eye, and pearly white in color, resembling thin convex disks. Around the edge there is a coarse network of ridges; while toward the center these ridges are finer. A red ring which indicates the embryo or developing larva

appears in the egg a few days after it is laid. In about eleven days, varying somewhat with temperature, the young larva breaks its way out of the shell and seeks to enter the fruit."

Having now seen how the apple worm begins work in the orchard, a few observations on the rapidity of its increase will be in order. Assuming that Mr. Saunders is correct in stating that each moth lays about fifty eggs, then each moth produces fifty other moths for the next generation. For the second generation, these fifty moths lay each fifty eggs, which develop into as many worms, going through the apples to the moth state, and culminating in twenty-five hundred moths.

Following up the calculation, it results in one hundred and twenty-five thousand worms for the third generation. All this amazing number from one moth in the spring. Now, if we accept it as a fact, that one worm destroys one apple, how many bushel crates will you lose, counting one hundred and fifty apples to the crate? Over eight hundred, had you that many in your orchard. Further under this head, suppose, instead of one moth in the spring, you had been visited by one hundred or one thousand moths?

Of course, it is not pretended that this estimate is literally correct. Deductions should be made for eggs not developing, owing to inherent defects. The depredations of birds, and predaceous insects, if any. And perhaps from other causes. To balance this, there are some facts that should not be overlooked. Mr. Saunders says each moth lays about fifty eggs; that is, stated in full, sometimes more than fifty and sometimes less than fifty eggs, so an average would make the true number about fifty. Again, it is a common observation that the majority of eggs laid hatch, whether laid by birds or insects; but the rule is general, not universal. Another very important fact, which is much against the orchardist and strengthens the calculation just made, is the minuteness of the egg, and consequent minuteness of the young worm, which escapes detection on this account while in burrows in the apple. Once in the apple, it is safe until, at least, the apple is destroyed.

CHAPTER IV.

The Worm.

We shall now treat of the apple worm, or larva, as it follows next in the order of evolution. The worm, within a short time after leaving the egg, enters the apple. It may be safely said that the worm remains in the apple twenty to twenty-eight days. It is of a pinkish color. It has six legs, by which fact it can be readily distinguished from the apple maggot, or any other worm. When matured and exposed to the hot sun, this worm can travel at a brisk gait. Like the spider, it has the power of suspension by means of a small and almost invisible fibre. It can climb this fibre and return to any place from which, by accident, it loses its footing. Evidently, from the slowness with which this maneuver is performed, this kind of exercise is undertaken only on rare occasions.

Here we may remark, that of the four phases of the codling moth, viz., the egg, the worm, the pupa and the moth, the worm offers the most vulnerable point of attack. The moth comes next, against which many unsuccessful attempts have been made and many unsuccessful devices em-

ployed. The eggs are too minute to be easily perceived; the pupa is concealed; the moths are extremely shy, and do their work in the night, concealing themselves in the day time; but the worm works in the open day, as well as in the night, and can, with pains, be located by the perforated apples and frequently by the juice drops on the leaves and fruit. His location fixed, you have him at your mercy, as will be fully shown further on.

It is in the larval stage of the codling moth that the damage is done. This fact necessitates a very close study of all the characteristics of this insect between the egg and cocoon state. Let us now note the conduct of the apple worm, immediately after it leaves the egg. Farmers' Bulletin No. 247: "Before entering the young apple, the larva feeds, as noted, on the leaves, but also for a day or two within the partial concealment formed by the calyx or blossom end of the apple. During several days, therefore, the little apple worms feed externally, both before they enter the calyx and within the latter."

When the young worm first enters the apple, the aperture made by its entrance is very small, but is enlarged, from time to time, to suit the size of the worm as it grows. This aperture is

kept open to supply the worm with air, just as the miners' shaft supplies air to the workmen under ground. At first view, we would take this hole in the apple to be a channel of entrance and exit; but not altogether so: the worm usually enters but once to destroy the apple; this done, he leaves the apple to return no more and to enter on a higher phase of existence.

As all animated creatures require more or less air to sustain life, an important advantage is gained over the codling moth in finding his air passage in the only stage of his being in which he is capable of doing injury, and at the very time when he is working havoc with the fruit. This vantage ground strengthened the writer's confidence that he could devise means by which the extermination of the codling moth could be effected.

The worm remains in the apple three or four weeks before it fully matures. This long stay of the worm in the apple is the orchardist's rare opportunity, as will be shown under the head of remedies.

The worm while in the apple is very sensible of danger; on the least interference will hasten to the extremity of the hole, and there remain until the alarm without has ceased.

From this fact, we learn that apples infested with worms, in course of maturity, may be roughly transported and handled, without the escape of a single worm; this assists materially in our future work of extermination.

But when the worm is fully matured, he is not at all timid; feeling his importance, he will leave his residence, under critical circumstances.

The worm now being grown, plump and strong, and nearly an inch in length, boldly leaves the cell of the apple, to enter into the cocoon state, the next step in the order of perpetuating his species. At this stage, the worm is very hardy; and is possessed of great tenacity of life. It will survive several minutes when immersed in pure coaloil, and is as hard to pull into pieces as a strong rubber string.

We are now in that phase of the codling moth in which the matured worms of the first generation leave the apples. As some of the apples are on the tree and others on the ground when the worms leave them, there are, as a consequence, worms ready to enter the cocoon and pupa in both these situations. Professor Bailey notes the same point when he says: "The greater number of the worms leave the fruit before it falls." So, according to this authority, the greater

part of the matured worms are on the tree, and the smaller part on the ground. So, whatever measures you adopt to destroy the worms, must embrace both of these conditions. The object in common of the worms on the ground and in the tree is to find some place of concealment in which to spin their cocoons. For this purpose, some ascend the tree from which the apple fell; others from the fallen apples burrow near or on the base of the tree; and sometimes the worm will ascend an adjacent tree for the purpose of spinning its cocoon.

As the migratory habits of the worm are very limited, it invariably enters the cocoon state on or near the tree on which it was matured. But this does not embrace extraneous causes, such as birds and animals carrying worm-infested apples to distant parts. A freshet or rushing brook would have the same effect. From well-established causes, the growth of the apple is checked from the moment it is entered by the worm. To discuss these causes here, would be foreign to a treatise of this kind. The superficial thinker will say, "This cannot be so, for I have seen large apples perforated with worm holes." He forgets that the apples attained their large size before they were entered by the worms.

The worm is now full grown, outside the apple, wandering about in search of some secret place in which to spin its cocoon. This done, the worm snugly within, enters on a new course of development, and within a few days assumes the pupal form, which will be the subject of the next chapter.

CHAPTER V.

The Pupa and Cocoon.

The word "pupa" signifies "Any insect in that stage of its metamorphosis which usually immediately precedes the adult, or imago, stage." (Webster's Dictionary.)

Farmers' Bulletin No. 247 gives the following description of the codling moth pupa: "The pupa is yellowish at first, but changes to a brown, and later to a bronze color. In about twenty days from the spinning of the cocoon the pupa, aided by its spines, pushes its way out of the cocoon. The pupa skin splits and the moth emerges, lays its eggs, and gives rise to another generation."

The transformation described above takes place in the warm season, during which time the four distinct phases of the codling moth family begin and close; or, as some writers have it, the life cycle is completed.

But in the last generation, which begins in the fall, passes through the winter and develops in the spring, a different process of development follows. The larva enters the cocoon stage as usual, but does not transform into the pupal

stage until the opening of the warm weather of the ensuing spring. From this, we learn that warmth is necessary to the development of larva to pupa, and of pupa to moth. Again, we learn that there is a greater embodiment of vital force in the larva than in any other form of the codling moth.

It is clear, then, that warmth facilitates and cold retards the development of this insect.

Neither the worm nor the pupa that follows require any food while encased within the cocoon; the larva, before he enters this state, is charged with sufficient power to carry him through to the moth stage; although this may consume a long and dreary winter.

In the summer months, the cocoon serves as a place of protection for the larva and pupa. In the winter months, it is a comfortable residence, in addition to that of security and protection. The cold resisting power of the apple worm is remarkable. A cocoon was found in the dead of winter, covered with ice and snow, the worm inside completely frozen, but soon revived on being placed near a heated stove.

The temperature of the winter yields considerable influence over the condition of the worm. Warm winters, and the frequent warm spells of

winter, force the larva prematurely into the pupal state; the same causes force the pupa, out of season, into the moth state. The moth now, in turn leaves the empty cocoon and entering on the barren fields of winter, soon dies of starvation and cold.

It is instructive to consider the various locations that the worm selects in which to weave its cocoon and propagate its charge. On whatever thing or place you may find the cocoon, it is never in plain view, or on the exposed surface, but in some concealed part. Never on the smooth limb of the tree, but always under the bark, or deep in some crack.

On account of the different kinds of things on which the worm places its cocoon, its transformation, and consequent introduction into foreign countries, is quickly, easily and often unconsciously done. Boxes of goods, bolts of cloth, lap robes, ladies' bonnets, overcoats are things on which the cocoon has been discovered, and by means of which, it is easy to see, the codling moth can be introduced into far distant places.

That the codling moth was introduced into New Mexico by such means there is no ground for a reasonable doubt. Not many years ago, it was the boast of the apple growers of Chaves and

Eddie Counties that not a single worm of any kind could be found in their orchards. It is one of the objects of this short treatise to bring back those good old times, by showing how to rid ourselves of this pest.

Inside the chamber of every cocoon appear consecutively three distinct phases of the codling moth: The larva, pupa and moth. So, in the winter months, inside these cocoons, dwell all the representatives of the codling moth family.

We will touch on this subject again in our chapter on Winter Remedies.

CHAPTER VI.

The Moth.

We have now reached the last stage of this insect, the flying moth.

The moth is very well described in Farmers' Bulletin No. 247: "The moth is but little known among fruit growers, and other moths are often mistaken for it. It varies somewhat in size, but the maximum spread of its wings is about three-fourths of an inch. The front wings are of a brownish gray color and are crossed with lines of gray scales, giving them the appearance of watered silk. At the tips of the wings there is a large brown spot, in which are many scales of bronze or gold. The hind wings are grayish brown in color. Taken as a whole, the coloring of the moth is such that when resting on old grayish bark, it is so like the bark that it is not easily distinguished."

If the apple-grower really wishes to become acquainted with the living appearance of the codling moth, as it appears while working in his individual orchard, descriptions in books, however good, cannot satisfy his inquisitive mind; he must

perform a few experiments himself. With this view, it is suggested that he catch an apple worm, place it in a gauze box or glass jar, and closely observe its motions and changes, until it comes forth a living, flying moth. Enclose a twig with blossoms or young apples on it in the same vessel. Now, with your high-power magnifying glass, note carefully his appearance and motions. In this way only can you learn how a moth looks and acts in his living state. By no means, would the writer be considered as disparaging the reading of books; it is a happy way of communicating our thoughts, and the only true way of perpetuating them.

Enough, though not all, has been said as to the general appearance of the codling moth.

We will now consider somewhat of the actions of this insect, and also of his habits and characteristics. The moth is of a wild nature, secretes itself during the day, and flies around after nightfall, depositing its eggs in secrecy and silence. It is said to fly in a nearly perpendicular position. As this mode of flying is necessarily slow, the moth moving in this position becomes an easy prey for predaceous birds and insects, where the latter are of nocturnal habits.

On the approach of day, the moths conceal

themselves in any convenient place. They will crawl under sacks or pieces of planks or into or under boxes left in the orchard. It is always hidden from view, as nearly so as possible. Owing to its wild nature, it is said to fly away on the approach of a light after nightfall. This has been controverted; but the best authority favors the first statement. One apple-grower stated that he had killed vast quantities of moths in the night time, by means of lights placed over tubs partly filled with water. But, on being interrogated by the writer, this apple-grower confessed that he could not distinguish one moth from another; that he would not know a codling moth if he should see one.

It is owing to the codling moth's wild nature and nocturnal habits, that we find among our best writers on this subject such expressions as these: "The moth is but little known among fruit-growers, and other moths are often mistaken for it." "Very few apple-growers are acquainted with the moth, as it flies at night."

As to the migratory habits of the moth, they are very limited. The writer does not believe that the moth, like the bee, ever mounts upward and flies away in search of new prospects and new orchards. On the contrary, extraneous causes

excepted, the codling moth lives and dies in the orchard of its origin. But suppose a crow let fall a worm-infested apple on some distant hill or plain, the case is different. The worm would evolve into the moth as usual. The moth would assume migratory habits and begin at once the search for an apple orchard, or some place to lay its eggs, in its endeavor to propagate its species.

The writer will cite a case, directly in point, which occurred last year in his neighborhood, supporting his assertion that the moth has very limited migratory habits; that it never, unless acted upon by some extraneous cause, wanders far from the place of its origin: Two orchards were separated by a cross fence, one on the east side, the other on the west; without this fence, the two would have made one solid block of apple orchard. The owner of the west orchard sprayed his orchard thoroughly several times during the season, reducing the quantity of worms very perceptibly. In the east orchard the worms ran riot, as the owner did not spray at all or take any measures to check the ravages of the worms. There was a uniform scarcity of worms over the west orchard, extending to within about ten rows of the east orchard; here there was a very perceptible increase of worms, showing con-

clusively that this increase of worms in the east side of the west orchard came from eggs planted there by moths from the west side of the east orchard. The distance across these rows may be placed at 150 or 200 yards, and this distance may be accepted as near the extent of the migration of the codling moth in a single season.

Long before the writer had learned of this case, he was convinced, by reflection and by observations in his own orchard, that the spread of the pest from its own action was slow indeed. How could it be otherwise? The egg is pasted to the tree without power of locomotion. The worm, when first hatched, is small and delicate, and must eat, then and there, or starve. As soon as the worm acquires sufficient strength, it enters the apple on the very tree on which the egg was laid; no migration here. The worm when matured, immediately leaves the apple, and in great haste seeks some secret place to spin his cocoon. The cocoon is stationary, so is the pupa eventually formed within. The shy and timid moth comes next, and, after continuously flying around for a few nights, it deposits all of its eggs and dies.

Apple worms of all sizes work in the orchard throughout the season. On the same tree, and on

any day, from early spring to the close of the season, you can find worms ranging in size from the smallest to the largest. This condition of things arises from the fact that the moth lays eggs on different days, and that each egg begins to incubate from the moment it is laid. Now, when we consider that the moth lays about fifty eggs, there must elapse quite a number of days between laying the first and the last egg. So, of course, the difference in the dimensions of the first and last worms would correspond to this length of time. The egg duct channel is charged with a certain number of eggs. The eggs nearest the outward aperture are harder, larger and more matured than those farther up the duct, and are laid first; those farthest up the duct are small and soft, but enlarge and harden as they approach the outward extremity of the duct, to be laid in their turn. When all these facts are considered, it is clear why there is such a difference in the sizes of the worms from the eggs of the same moth.

There is another cause for this difference: Eggs deposited on parts of the tree exposed to the sun would naturally mature earlier than those deposited at the same time in cool and shady places. Again, as cool and rainy spells of

weather retard and benumb the activity of the moth, this cause would conduce still more to the difference. Still, again, eggs laid during a warm spell of weather would hatch much earlier than eggs laid in a cold spell. This still further accounts for the difference in the sizes of worms of the same generation.

It is said that all the moths do not appear at the same time in the spring. We have already noticed that warmth is favorable to the development of the moth in all its stages. This being so, the first moths develop in those cocoons that are favored with warm and sunny places, and are the first in the orchard; others, being located in cool and shady places, are slower in their development, and consequently later in the orchard.

CHAPTER VII.

Moth Balls and Smudging With Ill-Smelling Compounds.

We will now notice some of the remedies the apple-grower, in his distress, has adopted in the hope of overcoming his enemy, commenting on their advantages and disadvantages.

“Moth balls hung in the trees and supposed to keep the moths away.” Of course, they were valueless, and soon passed away. There are many horticulturists who never heard of such a device. Our sympathy is excited by the earnestness betoken in the adoption of such a curious device.

“Smudging or spraying orchards with ill-smelling compounds,” however reasonable it may have appeared at the time of its adoption, had little or no value. This recourse was doubtless suggested by the well-known fact that smoke acts as a repellent on gnats, mosquitoes and other insects. On close view, as the result proved, this remedy was not founded in practical sense, and has long since been abandoned. Admitting that it was partially effective, and there is no ground

for the admission, who could afford to have ill-smelling compounds in his orchard throughout the entire growing season? It cannot be allowed that it was even one step of progression, leading to the present system of spraying with poisonous solutions against the codling moth; for this discovery was the result of pure accident.

CHAPTER VIII.

Sulphur and Calomel Remedies.

Plugging the tree with sulphur is another strange device to which the orchardist has resorted in his hard fight against the apple worm. The orchardist, knowing the close resemblance in the laws of animal and vegetable life, supposed that sulphur, when put into the body of the tree, would mix with the sap and enter the apple, and, there being taken as a food by the worm, would cause its death, in the same manner that vermin are killed on the bodies of diseased animals when sulphur is mixed and administered with their food. This experiment ended in failure, although it had some reason on its side. The main idea, to kill the worm by mixing poison with its food, was good. It is the ruling principle in our spraying system today. The mistake was in selecting the wrong material and in applying it in the wrong way; for could you in this way get a sufficient quantity of poison into the tree to kill the worm, would not the poison also kill the tree, or, at least, inflict a serious injury on the tree and the fruit? Who

would dare to partake of the fruit of a tree inoculated with a deadly poison?

A similar plan was attempted by plugging the roots of the tree with calomel. This plan also ended in signal failure. Any further comment on this subject is useless; for what is said of the sulphur remedy applies with equal force to the calomel remedy.

CHAPTER IX.

Banding Trees With Tarred Paper.

By this remedy the apple trees were wrapped with tarred paper to prevent the apple worm from ascending the trees to eat the apples up. The futility of this device evinces the necessity of some knowledge of the habits of the codling moth before taking active measures against him, or prescribing them for others to follow. If the tarred paper held the worm fast, the device would be effective to that extent; but it merely turns the living worm back, to go elsewhere, at pleasure. It would be the pleasure of the worm to find some convenient place in which to spin its cocoon, from which, in due time, the flying moth would emerge, ready to deposit eggs upon the fruit. When the matured apple worm is crawling about, all the harmful work that pertains to his generation has been accomplished. The proper thing now to do is to kill this particular worm, thus putting an end to the part he will play in the next generation. This, however, the tarred paper does not do; so we pronounce it a useless expenditure of time and money. Of

course, these worms, which the tarred paper is supposed to turn back, come from fallen apples and are ascending the trees to enter into the co-con state. What effect could it have on the majority of the worms that leave the apples on the trees, and never descend?

CHAPTER X.

Trap Lanterns, Vinegar and Molasses, Spraying With Water, Electric Lights, Wood Peckers.

Regarded as agencies for the destruction of the codling moth, all the things above enumerated, with the exception of the last, may be classed as failures, and as a consequence long since abandoned.

But many respectable authorities encourage the presence of the wood peckers in the orchard as a valuable ally in the fight against this insect. They claim that the piercing eye of the wood peckers detects the cocoons in their secret places, and plucks therefrom the embryo insects. It is frankly conceded that this bird does much good in destroying this insect, but the good is over-balanced by the injury he does by perforating and girdling the trees. In the growing season, the sap exudes from these perforations, attracts noxious insects, and causes sunscald. There is an ugly scar; it sours, and fungus sets in. In the winter, through these holes the cold penetrates to an undue depth. The tree is always impaired, and sometimes dies. Away with the wood pecker!

And here we may observe, that no natural enemies of the codling moth should be allowed in the orchard that inflict damage on the trees or on the fruit.

Since writing the above, the author's attention has been called to an article in the Year Book of 1911, U. S. Department of Agriculture, showing the utility of predaceous birds in apple orchards. In this article, the woodpecker is a conspicuous figure. Much credit is given to him and other insectivorous birds. In addition to what has already been written, and modifying it to some extent, it may be safely affirmed that all insect-eating birds, that do no material damage to fruit or tree, should be encouraged to visit and reside in the orchard. No doubt there are localities in which the woodpecker does little or no damage to the trees, while he destroys large quantities of worms and pupas. In such places, it is sound policy that he should be spared. However, too much importance should not be ascribed to the assistance of the birds; for experience abundantly shows that they alone are wholly inadequate to overcome the apple worm. We all know that the birds have inhabited this continent for ages past; that, when the forest

was cleared and the orchard set, they forsook the forest, entered our orchards in large numbers, made them their breeding ground and favorite abode; and yet, with all the advantage of being first in possession, and of being familiar with every tree and twig in the orchard, they signally failed to prevent, in the first instance, the entrance of the apple worm, and much more so to effect its expulsion. Further, it must be remembered that the first entrance of the codling moth is in small numbers, never in swarms; and yet, the birds, with their keen eyes and finely attuned ears, failed to detect the intrusion. How silly, then, to expect the birds to overcome them after they have established themselves by thousands!

Still, in justice to the birds, it must not be overlooked that the moth comes and deposits its eggs in the night, while the birds are asleep. Were the codling moth a daylight insect, the police efficiency of the birds would be vastly increased.

Local conditions should govern this question.

CHAPTER XI.

The Bandage Remedy.

When the handage remedy was first introduced, it was severely ridiculed by some brilliant writers who should have known better; for experience has demonstrated its usefulness, as an auxiliary remedy to spraying. The inventor claimed it was good for everything; the critic, that it was good for nothing. Both erred. The first claimed too much; the last denied too much. The inventor, however, deserves some praise for inventing that which is useful; the critic none, for he ridiculed and condemned that which is useful.

Here follows some of the ridicule: "Does the apple worm bore your apples? Bandage the butt of your tree and he perisheth forthwith." Again: "Long live king humbug! He still feeds fools on flap-doodle, and many of them have large and flourishing families, who will perpetuate the breed to the remotest generation." This piece of criticism was suggested by reading a newspaper article recommending banding trees as an

efficient remedy against all insects that injure trees. The inventor evidently proceeded on the palpable error that all insects evolve into the larval form from eggs laid on or in the ground, and must crawl up the tree before they can damage the tree or its fruit. He was wrong in the extensiveness of his claim, but right in part as to the codling moth, which saved his claim from oblivion, the fate of all the silly remedies up to this time. The reader will remember that worm-infested apples frequently fall to the ground. When the worms in these apples mature they leave the apples, and many attempt to ascend the trees for the purpose of entering into the cocoon state. When the worm reaches the bandage, having found a convenient and secret place, he forthwith crawls underneath and spins his silken cocoon. It is the worm from the fallen apple to which this remedy almost exclusively applies.

A reliable horticulturist, who has had considerable experience in using the bandage system, says that in all his experiments he had never found a single worm above and under the bandage; but that he had caught many under the bandage, on the side next to the ground. This

seems to warrant the conclusion that the worm does not descend the tree to enter the cocoon state.

Had it been true, as the inventor supposed, that all insects must first crawl up the tree in order to reach the fruit, his invention would not have fallen far short of his extensive claim.

It should be noted that one generation of worms must have done their work of devastation in full before being entrapped under the bandage, and that these are only a small part of the entire generation, only those from fallen apples. Being only effective, in part, as we see; yet, it was the only remedy which had any real merit at the time of its discovery.

Standing alone, the bandage system would not bring the worms even under perceptible control; for, as we have seen, only a small percentage of the worms are in the fallen apples. So, should all of these be caught, which is scarcely probable, the larger part would still be left to perpetuate the species. It is only in connection with other remedies of a more thorough kind that this one is valuable, as will subsequently be seen. And, although first in the order of discovery, it is not first in practice and least of all in efficiency.

In U. S. Bulletin 247, this subject is treated quite fully, which we will now quote:

“The use of bands to trap the full-grown larvae of the codling moth was the only remedial measure of value before arsenical sprays were discovered. If an orchard has been given good care and spraying is thoroughly done, it may be unnecessary to use bands. If, however, the trees are old and cracked and have holes in the trunk and branches, or planted close together, so that spraying is difficult, the use of bands will materially aid in bringing the insects under control. Banding for this insect is simply affording it a good place to spin its cocoon, and killing the larva or pupa after it has gone beneath the band. Cloth bands from, 10 to 12 inches in width, are folded once lengthwise and placed around the tree. They can be fastened in such a way as to be easily removed and replaced, by driving a nail through the ends and then nipping off the head at an angle, so as to leave a sharp point. If a tree is large, one band should be placed on the trunk and one on each of the larger limbs. Cloth bands of any heavy, dark-colored stuff are much preferable to bands of hay or paper. When bands are used, the tree should be scraped

clean of rough or loose bark, to leave as few other attractive places as possible in which the larvae might spin cocoons. Inspection of the bands should be made regularly at intervals of ten days, and all larvae and pupa found beneath them should be destroyed with a knife. If used alone, banding is but little effective in badly infested localities, but it is a most valuable adjunct to spraying. Under no circumstances, should banding be used as a substitute for spraying."

As we intend to make banding a part of our exterminating system, though not, by any means, an indispensable part, it is recommended that they should be put on in the early spring, as this is the most convenient time. They will not be in the way. So, when the fight begins in earnest, you will not be bothered running around with your bands, when you should be at other business.

To fasten the bands around the trees, use a piece of stiff wire about the size of hay-binding wire, four or five inches long, and a loop in one end large enough for the insertion of your finger. You will find this device for fastening and unfastening the bands more convenient than the nails referred to in the bulletin.

At the expense of repetition, and that the use of this device may be clearly understood, we will say, that the bands do not entrap any worms of the first generation until after they have wrought destruction to the apples to the extent of their numbers. So, when you catch under the bands one thousand worms, you may positively know that you have lost one thousand apples. And, if it be true that each moth lays forty or fifty eggs, you may know that you have saved forty or fifty thousand apples from the ravages of the worms of the second generation.

We shall have occasion to revert to this subject again.

CHAPTER XII.

Spraying Remedy.

Next, in the order of discovery, comes spraying with arsenical compounds, the result of an accident as applied to the apple worm. As its introduction into the apple orchard marks a new era in this industry, an account of the manner by which it was brought about will be both entertaining and instructive. Year Book of the Department of Agriculture, 1899:

“With the writings of Walsh, immediately followed by those of Riley, a new era of excellent remedies founded upon accurate knowledge of the economy of the insects in question began. Aside from the excellent recommendations which had been made with regard to agricultural practice, as it has been termed, and which refers to such matters as rotation of crops, different times of planting and harvesting, and different methods of cropping, etc., the first great start which the new economic entomologist received from the remedial standpoint was probably the introduction of paris green as an insecticide.

Paris Green.

“At the time this substance was introduced, the best insecticides in use were the various forms of soap, tobacco, quassia chips, carbolic acid, and hellebore, although the last was a comparatively new remedy and comes into general use at about the time of the spread of the important currant worm in the late fifties. The spread of the Colorado potato beetle into the Eastern States, between the years 1859 and 1872, started a great deal of experimental work in regard to remedies, and paris green was first used at some time early in the sixties. The name of the first man to use it is not known, but by 1868 it was being used by several persons. The editors of the *American Entomologist* (Vol. 1, p. 219, July, 1869) recommended it confidently as a result of experiments, tried both in 1868 and 1869, and in the former year Mr. J. P. Wilson, of Illinois, took out a patent for one part paris green and two parts mineral paint, to be used to kill potato bugs. The use of paris green against the cotton caterpillar seems to have been first suggested by Riley at the St. Louis meeting of the National Agricultural Congress in 1872, although in January, 1871, T. W. Mitchell, of Texas, se-

cured a patent for the use of a solution of arsenic against this insect. Its extensive use against the cotton caterpillar has been a great boon to the cotton planters of the South.

In 1872 Dr. Le Boron recommended the use of paris green against the spring cankerworm, which was abundant that year. This was the first recommendation for its application to fruit trees. Four years later Prof. A. C. Cook repeated the recommendation, and in 1878 the advice was followed by many apple-growers in Michigan. In 1878 Mr. J. S. Woodward, of Lockport, N. Y., advised Mr. Edward P. Hayes, of Niagara County, N. Y., to spray his apple trees with paris green against the canker worms. The following autumn Mr. Hayes noticed that the apples in the sprayed part of the orchard were much less infested by the codling moth than in other parts of the orchard. Mr. Woodward visited the orchard, verified the fact and reported it at the January meeting of the Western New York Horticultural Society. Mr. Woodward, writing to the late E. G. Lodeman, when the latter was engaged in preparing his work entitled "The Spraying of Plants," said: "I shall never forget this, because of the way in which I was jumped upon

as a crank." Almost at the same time, the same discovery was made by Prof. Cook, in Michigan, and by Hon. John M. Dixon, of Oskaloosa, Iowa, the latter, however, using london purple instead of paris green. This discovery has resulted in the use of arsenical poisons in enormous quantities in regular orchard work. It was adopted slowly, on account of the supposed danger from its use. Even Riley, who had been so prominent in urging the use of arsenical poisons against the Colorado potato beetle and the cotton caterpillar, writing in the Farmers' Review, in the autumn of 1880, says:

"Prof. Cook, of the Michigan Agricultural College, has lately recommended them (paris green and london purple) for the killing of a strawberry leaf-beetle which, as he shows, lives in its larva state beneath the ground; also for the destruction of the apple worm. In the first place, it were eminently dangerous to use such a poisonous remedy while the plants are fruiting, and I would not recommend it even later in the season until every other available remedy had been tried. In the second case, it is even less to be recommended. It will undoubtedly serve to kill many of the first brood of worms, and this

is desirable; but there is as good evidence that lime or plaster dusted onto the young fruit has much the same effect, while experience has shown that the bandage system and other methods of fighting this insect, when judiciously and persistently adopted from year to year, are sufficient to insure a crop at trifling cost. Finally, if the poison is so persistent in the calyx as to have any effect in destroying the second brood of worms, that will only heighten the danger to those persons who subsequently eat the fruit."

"Professor Cook, in a paper read before the American Association for the Advancement of Science at its Boston meeting, 1880, as well as in subsequent papers read before the Michigan Horticultural Society and the Society for the Promotion of Agricultural Science, gave his annual experience, and was the most ardent advocate of this treatment for the codling moth. The careful experiments made by Forbes in 1885 added great weight to the remedy, on account of his wide reputation for care and conservatism. E. S. Gopp, then at Geneva, N. Y., also published results of some careful experiments made in 1885. In 1887 experiments made by W. B. Alwood and E. R. Cushman for the Division of

Entomology emphasized the value of the treatment, which the writer did not hesitate to strongly recommend in his article on the codling moth, published that year. As Lodeman has shown, however, very few of the most progressive orchardists adopted the remedy until after the establishment of state agricultural stations in the spring of 1888, when added emphasis was given by the experiments and recommendations of the newly appointed entomologists and horticulturists.

“The same substance, paris green, was first recommended against the plum curculio by Mr. G. M. Smith, of Berlin, Wisconsin, 1871, but the idea that it would be efficacious was generally discredited. Mr. L. Luther Bowers, of Herndon, Va., used it in 1880 with good results. Mr. William Creed, of Rochester, N. Y., recorded the complete success of two years’ work against the insect in Purdy’s Fruit Recorder, in November, 1885, and during the same year Forbes experimented most carefully in Illinois. In 1887 W. B. Alwood and Herbert Osborn, working for the Division of Entomology; A. S. Cook, in Michigan; and C. M. Weed, in Ohio, also carried out successful experiments, and the remedy has

since come into general use. By 1887, in fact, arsenical poisons had become the standard remedy against nearly all mandibulate or growing insects. Their use in other countries has been brought about very slowly, and they have but slight vogue in Europe today. Miss Ormerod, in her numerous reports, has recorded the difficulty which she has experienced in securing their adoption by English horticulturists. The English colonists, however, more enterprising and less conservative than the home people, have taken them up, and they are used today in New Zealand, Australia and South Africa."

This lengthy extract gives us a fair idea of the manner in which spraying with arsenical poisons was first introduced; and some disadvantages are also mentioned. The chief advantage that arsenical spraying has over all other remedies, with which the writer is acquainted, is, when properly done, its destruction of a large percentage of the worms of the first brood. For, it must be remembered that all worms of subsequent generations, are traceable to the first generation. Therefore, the more thorough the first spraying, the less there will be to encounter on the second tilt. Three things are indispensa-

ble in spraying: It must be done at the right time, in right manner, and with the right material. If all these are conjoined in the first spraying, the percentage of destruction will run up into the nineties. But, if done at the wrong time, in the wrong manner, and with the wrong material, all your time, labor and money goes for naught. Let us, then, briefly consider the proper time and some other matters naturally connected with it, inasmuch as we are engaged in the huge undertaking of showing, how the codling moth may be exterminated. There is some discrepancy of opinion as to the proper time for spraying.

It is not governed by latitude, altitude or the seasons; although it is influenced by those factors. We know that we should spray earlier in New Mexico and Texas than in Michigan and New York; yet the difference in the latitude between these states is not a sure guide to the proper time to spray.

It must be governed by a knowledge of the time when the moth usually deposits her eggs, and the condition of the apples in the particular orchard to be sprayed. One or two quotations from recognized authorities on this subject will suffice. Prof. Clarence M. Weed says: "In spray-

ing, soon after the blossoms have fallen off, when the apples are from the size of a pea to that of a hickory nut, and before they have turned downward on their stems, the spraying should be done."

Prof. Gillett, another high authority, says: "That while the moths begin to appear about the time of full bloom, they don't begin to lay eggs until the majority of the apples in the orchard are one-half an inch in diameter; when they are three-fourths of an inch, they are laid freely. As soon as the little apples lose their fuzzy covering, the moths lay their eggs very largely upon the cheek of the apple, but never in the blossom. Later it finds its hiding place in the blossom end of the apple. After the blossoms have fallen and the apples have attained a little size, is the time to spray and not before. It takes seven days for the eggs to hatch and about 70 per cent of the worms enter the blossom end."

Too much stress cannot be laid on the above quotation, as it goes straight to the very marrow of the subject. "Prof. Gillett, who wrote the above, has raised these moths in great numbers at the governmental experiment station, and is

considered the best authority on this subject in the West.”—(Editor Pecos Valley News.)

In order to acquire a full and accurate knowledge of the habits of this insect, it must be confined in such a way that, while its action is free and natural, yet it cannot escape. This, it seems, Prof. Gillett has done.

You will find on a careful reading of these remarks made by Prof. Gillett, that you should not spray while the apple trees are in blossom. This practice, which is still kept up to a considerable extent, is founded on a misconception of the operations of the codling moth. The followers of this practice believe that the moth deposits her egg or eggs in the end of the blossom, and that the apple grows over and encloses the worm, which grows and feeds as the apple grows until the worm matures and tunnels out. Scores of young apples have been opened to discover the truth of this assertion, without the discovery of a single worm. There never was and never will be an apple worm in an apple without there being, at the same time, a hole of entrance. It has also been discovered that the blossoms are injured by spraying; that it kills bees which are necessary for pollination. Of course, it is a pos-

itive waste of labor and material, as the moth has not yet laid her eggs. In some places it is prohibited by statute. The U. S. Agricultural Department, as the writer is informed, recommends making this practice a grave misdemeanor. The spread of information is needed more than penal statutes; for surely, no one would knowingly injure his own fruit.

Another important question which should be disposed of under this head, is whether the spray should be applied before or after the moth deposits her eggs. Before, always. Farmers' Bulletin, U. S. Department of Agriculture, says: "During several days, therefore, the little worms feed externally, both before they enter the calyx and within the latter. And the object of spraying is to insure their being poisoned by thoroughly coating in advance, with an arsenical mixture, the leaves, and especially the blossom end of every fruit, before the shutting up of the lobes of the calyx. Most of the larvae enter the calyx after it is closed, and then are beyond the reach of any poison later applied."

To spray intelligently and most effectually, we should know those particular places on which the moth deposits her eggs. The bulletin just

quoted says: "The moth lays her eggs, a few days after emergence, on the leaves of apple or other food plant, or on the fruit." But the bulletin does not say that the eggs are laid in the blossom end, nor does it assert that they are not laid in the blossom end. But, judging from what the compilers of this bulletin have written of the egg, the larva, and the proper mode of spraying against the latter, it is quite clear that they were not of the opinion that the moth deposits her eggs in the blossom end of the apple.

Prof. Gillette, as quoted in a newspaper (the writer has not read his works), is positive that the moth never lays her eggs in the blossom end of the apple.

Prof. Weed states: "The small chocolate moth deposits its eggs in spring in the blossom end of the young apple before the latter has turned down on its stem."

Prof. Bailey says: "A single egg is laid in the blossom end of the young apple, and in about a week it hatches and the young larva eats its way into the apple." Now, if it is true that the egg is laid in the blossom end of the apple, it is absolutely essential that the spray be applied at this place before the egg is laid; for, if after-

wards, the egg would be between the poison and the apple, and when hatched the worm would gnaw into the apple without injury, the poison being left behind untouched.

But if, on the contrary, as Prof. Gillette states, the egg is never laid in the blossom end, and the spray is applied after the egg is laid, but before it is hatched, the young larva would encounter the poison in attempting to enter at the blossom end, which would not be the case if the first supposition is correct. This seems to be the only practical difference resulting from the two theories.

If the spraying is done after the blossoms have fallen and the apples have attained a little size, about the size of a pea, practically all the poison, except that which adheres to the blossom ends of the apples, will have passed off with the fallen fuzz, before the first eggs are laid. After the fuzz has passed off and the apples have grown to about one-half inch in diameter, the moth, for the first time, begins to deposit her eggs upon the smooth surface of the apple. But, as we have seen, this smooth surface is clear of poison. The only effective poison, in this state of things, is in the blossom end of the apple, and

upon the leaves, if not washed away by the rain. The difficulty loses much of its serious nature when we consider that 70 or 80 per cent of the young worms enter the apple at its blossom end, where they will meet with poison if the spraying was well done; the sprayed leaves will also kill a few. Still a difficulty is presented, to meet which, it has been recommended that a second spraying be given within ten days or two weeks from the first and this is about the time a young apple, the size of a pea, requires to reach that of a hickory nut, or about one-half inch in diameter. If the young apple were free of fuzz and were coated with poison shortly after the blossom falls, by the time it reached the dimensions described above, this small quantity of poison would be so thinly spread over the surface of the apple, if spread at all, as to lose all its virtue. Since it has been shown that the eggs are never laid in the calyx, but upon the smooth cheek of the apple, upon the apple leaves, and other plant food, and after the apple has attained the size of one-half inch in diameter, why spray so early as is recommended by some writers on this subject? Spraying at any time, before the eggs are laid, after the apples have attained a consider-

able size, presenting a smooth surface and before they turn down on their stems, it seems, would be sufficient. It is necessary that the cheeks of the young apples should be coated with poison, for 25 or 30 per cent of the worms enter the apples at this place. So it is clear, if the spraying is done when the apples are not larger than a pea, a second spraying is needed after the fuzz drops and the young apples present smooth cheeks. But, if the first spraying is done after the apples are of considerable size, as has been suggested, the expense of one operation will be saved; besides this, the spraying material will be fresh and possessed of all its virtue. Or, in other words, the killing power of the poison will be fresher and stronger.

This very early spraying seems to have been founded in a misconception of the true habits of this insect. The moth was supposed to lay her eggs on the apples when they were very small; this, as has been shown, is not the case. Another error was, that the moth laid her eggs in the calyx. And both these errors had strong semblance of reason to support them. For why should the moth be out with the blossoms if not to deposit her eggs? And how plausible to con-

jecture that the egg was laid in the blossom end of the apple, from the fact that a very large majority of the holes of entrance are found in this place?

As all the authorities that the writer has consulted recommend, in different words, that the spraying should be done when the apples are small, it would be rash to depart from this instruction, all at once. Practice either proves or disproves the correctness of all theories. A test could easily be made by spraying the orchard when the apples are about the size of a pea, leaving unsprayed a few rows, to be afterwards sprayed when the apples attain a larger size, but before the eggs are laid. Then the prevalence of the worms in the one or the other portions of the orchard sprayed at different times would indicate the time when the first spraying could be most beneficially done, of course, other things being even.

As to the manner of spraying, it is almost needless to say that it should be thoroughly done. No recommendation is made as to the particular kind of machine to be used. There is much difference of opinion on this subject. No doubt there are many excellent spraying machines of

different makes on the market. The quality of high-power is strongly recommended. This will enable you to throw the spray against the wind, and to force it down into the ends of the apples. The machine should, also, have an adjustable nozzle, so the spray can be thrown in any direction the occasion may require. Of course, the team should be quiet and tractable. It is very essential that the proper men should be employed to do this kind of work. Experienced hands are always best when they can be had; if these cannot be had, be sure to employ none but quick, active, attentive, and intelligent men. The slow, droll, inattentive man has no suitable place in the orchard.

Some, from a lack of knowledge of the habits of this insect, apply the spray to the trunk of the tree and on the ground around its base. Such a practice is not only wasteful but positively injurious, as will presently be shown.

In addition to what has been said on the manner of spraying, an excerpt from "Fruit Growing in Arid Regions," by Paddock and Whipple, will be sufficient. On page 382 we find the following directions: "Pumps with metal valves should be used for the application of insecticides

or fungicides in liquid form, as the materials harden or decompose leather valves so that they last but a short time. If bordeaux mixture is to be used, all parts of pumps and nozzles that come in contact with the mixture must be made of brass, as the chemicals very soon destroy iron. Wooden tanks must take the place of metal. If the pump is to be used with a tank or barrel, it is also important to have some kind of attachment that will keep the liquid agitated, so that the materials in suspension will not settle. A common error is to purchase a pump of too small capacity, because it is cheaper. A smaller, cheaper pump usually means less accomplished in a day with the same help and a poorer job, with a greater expenditure of labor. It is often important to complete the spraying in as short a time as possible after it is begun. To do this, a pump of large capacity with two or more leads of hose is necessary. The hose to which the nozzles are attached should be as light as possible and still have the requisite strength—a hose of good quality with heavy wall, but small caliber. Bucket pumps are sold by different dealers at prices ranging between about \$2.00 and \$8.00. They are suitable for use among garden veget-

ables, shrubbery and all low plants, but should not be purchased for orchard work if one has more than a very few trees to treat.

“If one has light spraying to do and is without help, the compressed-air sprayers are very convenient. Large compressed-air machines that derive their power from gearing attached to the wagon wheel are specially adapted to the treatment of low plants, but it is doubtful whether any spraying machines of this class on the market are well adapted to the spraying of large orchard trees when the wagon must stand still a large part of the time while the spraying is going on.

“When large orchards are to be sprayed, it is a matter of necessity and economy to use tanks that will hold 200 and 300 gallons, and pumps of large capacity. In such orchards gasoline power sprayers are most useful and are becoming more and more common. Heavier engines are now being used, those of two and one-half and three-horse power being preferred. They are more stable and give less trouble than lighter ones.

“The first requisite for a good job of spraying is a pump that will give plenty of pressure in the hose. Then, if one has a good spraying nozzle

and a liquid that is free from solid particles of a size to clog the sprayer, there will be no difficulty in securing a good spray."

This much as to the capacity and character of the machine advised to be selected. There is no doubt as to the value of the views expressed by these authors on this subject.

We will now quote from the same work the method of application. Page 368:

"The methods of spraying for the codling moth have changed rapidly in recent years. Formerly the trees were often sprayed eight and ten times in a season, but in spite of this a large percentage of wormy apples was the rule. Growers who followed this practice failed to appreciate the fact that about three-fourths of the first brood of worms enter the apples at the calyx. This is where the importance of filling each calyx cup with poison comes in. If all of the first brood could be killed, there would be no second brood and consequently no worms late in the summer, when the greatest damage occurs. Many orchardists appreciate this fact, and so devote all their energies to applying the first spray at the proper time and in a thorough manner. This is a job that cannot be neglected. As

soon as the petals have mostly fallen, spraying should be begun, and it must be persistently followed. The calyx remains open for only about six or eight days, and after this the spraying is practically useless for the first brood of worms. If a second application is thought advisable, it should be given about thirty days later. Some of our progressive growers are now relying on the first spraying, performed at just the right time and applied in a thorough manner, and are meeting with good success."

There are many different formulas for spraying. As already indicated, they have undergone changes in recent years. Other changes will soon follow. Too many shrewd minds are concentrated on the study of this subject not to open the door to further progress. A few extracts from prominent authorities will suffice. Paddock and Whipple say that "three pounds (arsenic) to each one hundred gallons (of water) is the most that should be recommended."

Clarence M. Weed recommends paris green or london purple, "in the proportion of one pound to two hundred and fifty gallons of water, or better combined with the bordeaux mixture."

U. S. Government Bulletin No. 247, page 13:

“Paris green is probably the best known of these arsenicals. It is a definite chemical compound of arsenic, copper, and acetic acid, and should have a uniform composition. It is a rather coarse powder, but raises in price from year to year with the fluctuation in the cost of the ingredients. It may be prepared for spraying as follows:

Paris green, pounds.....	1
Lime, pounds.....	3
Water, gallons.....	150

The lime should be fresh and should be slaked in quantities as required. Mix the paris green with a little water until a paste is formed, and then add this to the required amount of water, to which the lime has been added. A good average strength to use is 1 pound to 150 gallons, but it must be weaker on trees with delicate foliage. Many fruit-growers are using it on apple trees as strong as 1 pound to 100 gallons, but injury to foliage often results.

Schiele's green is similar to paris green, but differs from it in lacking the acetic acid. It is a much finer powder than paris green and more easily kept in suspension, and it costs only about one-half as much. It is employed in the same way as paris green.

Arsenate of Lime With Soda.

“In the preparation of this insecticide, the following formula may be used:

White Arsenic, pounds.....	1
Sal-Soda (crystal) pounds.....	4
Water, gallons	1

“The above ingredients are boiled until dissolved, which will be in a very few minutes, and the water lost by evaporation is then replaced. To 40 or 50 gallons of water a pint of this stock solution and three to four pounds of freshly slaked lime are added. This excess of lime is always desired by fruit-growers, as they can then see by the amount and distribution of the lime on the foliage how well the spraying has been done. This formula has been thoroughly tested and has been found to be not only as efficient as the other solution, but far cheaper.”

As the above formulas and suggestion are taken from the best authorities attainable, it is safe to say that they can be relied upon by the prudent orchardist. It is also advisable that the orchardist should prepare his own solutions. By so doing, he knows the nature and strength of his spraying material; besides, it is cheaper, and, in addition, he gains an experimental knowledge of those details on which his success depends.

As all these mixtures contain deadly poison, strict caution should be observed, during and after their use. An apple grower in this neighborhood lost five valuable milk cows by one of his hands leaving in an exposed place a quantity of the poison. After the spraying is over, all empty wooden vessels should be destroyed. In order to emphasize this caution, Farmers' Bulletin No. 247, U. S. Department of Agriculture, is again quoted. Page 14: "At all times the greatest care should be taken to prevent accident with these compounds, which are of the most poisonous nature. All packages, boxes, or bottles containing these materials should be plainly labeled and kept under lock. The utensils with which the mixtures are prepared should be thoroughly cleansed after use."

We will now notice some of the difficulties encountered in spraying from unfavorable conditions of the weather. The most common of these is the wind. A gentle breeze, while it is of no advantage, presents no serious obstacle, and the operation need not stop on that account. But if the wind is high, the spray will miss its mark, being blown away, and the spraying must be deferred until a quiet day. Whether this delay

will be serious is owing to the circumstances of the particular case. If the orchard is large and the spraying outfit small, damage may result. This would surely be the case should the high wind continue an unusual length of time, or be followed by other bad weather, preventing the spraying. But should the orchard be small and the spraying outfit competent no serious consequences need be apprehended.

The hardest difficulty to overcome, is rainy weather at the very time when the orchard is in pressing need of spraying. This difficulty frequently occurs. But it is to the apple worm's advantage; for though bad weather may prevail, yet it cannot stop the ceaseless working of the worm.

Another difficulty is presented by the lack of uniformity of position of the leaves and apples on the trees. Authors on the subject of spraying write as though all the young apples were upturned, inviting and awaiting the reception of the spray. If such were the case, the poison could be more accurately applied, vastly increasing its deadly effects. The fact is, many of the young apples and leaves naturally grow downwards. A large majority, however, grow in an upward di-

rection; and to this majority, catching the spray, we are chiefly indebted for the destruction of the larger part of the worms. A considerable number of small, apple-bearing limbs are bent downwards from the weight of the preceding year's growth of fruit and foliage. And nearly all twigs and small limbs that grow underneath large, horizontal branches, extend in a downward direction. All of these of the downward tendency are hard to reach with the spray, or, if reached at all, little or none of the spray finds its way to the calyx ends of the apples, but necessarily drips to the ground. These facts being clearly understood, the necessity of having a thoughtful, careful sprayer becomes very apparent. When all these difficulties, and others not mentioned in this place, are carefully considered, we begin to understand why the codling moth cannot be exterminated by spraying alone. The recent improvements in spray pumps that throw the spray in all directions, can alleviate, but not remove, the hardship.

Having considered some of the difficulties in the way of spraying with arsenicals, we will next consider the damages which arise from the same cause.

Should the spraying solution be too strong, the tree may be wholly or partially defoliated. While death seldom results from this cause, the vitality of the tree is seriously impaired, and it is safe to infer that its longevity is shortened.

But there is another danger of a still more alarming nature, one that threatens the life of the orchard. Scientific investigations have discovered that arsenical spray flowing down the trunk of the tree to its base and roots has caused them to become diseased and to decay. Death, of course, soon follows when this is the case. A clearer insight into this important subject, than any the writer can make, will be had by a quotation from Paddock and Whipple on "Fruit Growing in Arid Regions," pages 360-2: "Root-rot.—Orchardists and experiment station workers alike have been puzzled for several years over the cause of root-rot in apple and pear trees. The name conveys at once the condition in which the trees are found. In some cases no injury is to be seen above ground, but when the tree dies, it will be found to be girdled just below ground, and most of the roots are decayed. In other cases, strips of dead bark extend up the trunks and often into the larger branches. In such cases,

the first indication of disease is the appearance on trunks and branches of dark brown spots caused by the exudation of sap. As the disease progresses, the bark dries down to the wood, all of the involved part taking on the dark color. Such trees usually ripen their foliage early in the fall, and the bark of the branches has a peculiar reddish coat. Many trees die in mid-summer, with fruit and foliage clinging, the second after symptoms of trouble were noticed. The inner wood of the branches of some of the affected trees is dark-colored, or black-hearted, a condition which has popularly been supposed to result from injury by frost alone. Another symptom which seems to be associated with this trouble is the splitting of the bark on the trunks. Such wounds bleed profusely, and it may be that some of the excessive bleeding which sometimes takes place from wounds made in pruning, may be due to the same cause. In all cases, the starting point is either at or below the surface of the ground. Fungi may be responsible for some of the dead trees, but this has never been definitely determined. The common pear-blight may also work in the roots of apple and pear trees, but this is unusual.

“The authors have spent much time over this all too common disease, but they were unable to arrive at any conclusion. Fortunately, our co-worker, Dr. W. P. Headden, became interested in the subject, and in a recent bulletin he gives the results of his investigations. He found upon analysis that the inner bark and wood of affected trees, not dead trees, contained a large percentage of arsenic, as much as 12.77 parts in a million. All fruit-growers know that even a small amount of soluble arsenic in the soil is fatal to vegetation, but they have felt safe in using large quantities of the various arsenical sprays for the reason that these forms of arsenic were supposed to be insoluble. It has been the custom in some sections to spray from six to twelve times a season for the codling moth. The appliances were often crude in form, consequently much spray was wasted and was deposited on the ground. Naturally the greatest accumulation is around the base of the tree where the injury occurs. Analysis of soil taken from near the base of the trees, to the depth of one foot, shows that arsenic has accumulated in varying amounts up to 61.3 parts of arsenic acid in a million of soil.

“Even such large amounts of arsenic would

be harmless if it remained insoluble, as had been supposed. Dr. Headden finds, however, that the alkali salt solutions, which are abundant in all arid soils, are solvents of arsenic and so are constantly bringing this extremely poisonous material into solution. This action is of course greater in some soils than in others, depending on the constituents present.

“This condition is indeed serious. We have no poison other than the arsenic preparation with which the codling moth may be successfully combated, and if we are to grow apples and pears successfully, spraying cannot be dispensed with. In the bulletin mentioned above, Dr. Headden sums up the situation as follows: “I have no remedy to suggest for either condition. Preventive measures are, so far as I can see, our only recourse. Those which suggest themselves to me are: To remove the arsenic-laden soil from about the crown of the tree and replace it with fresh soil; to use standard brands of lead arsenate in preference to the arsenite of lime or white arsenic, sal-soda, and lime; to use as little lead arsenate as possible. I have been told that good results have been obtained by using $2\frac{1}{2}$ and even 2 pounds of pasty lead arsenate to 100 gallons of

water, but the spraying must be done thoroughly. Spray no oftener than is absolutely necessary. If I am not mistaken, Professor Gillette has found that 95 per cent of the effect of the whole season's spraying was obtained by the first spraying when thoroughly well done. Some device should be used to prevent the spray material from running down the trunk and collecting at its base, or it would be still better to make provision for gathering the whole of the drip. Water rich in alkalies should not be allowed to flow close enough to the tree to permit of the deposition of the alkalies in the soil about the trunk of the tree. Concentrated lye, if used to kill woolly aphis, should not be applied to the soil at the crown of the tree or permitted to flow down and collect there."

From the statements in the above passage, it cannot be doubted that arsenical sprays have a deadly effect upon vegetable life. The difficulty as presented is this: If we do not spray with arsenicals, we cannot successfully raise apples and pears. If we continue to spray with arsenicals, the orchards must ultimately be destroyed in the arid regions at least.

It will be noticed that preventive measures

are recommended. One is remove the poisoned earth and replace with fresh earth. The details to be performed to effect this purpose are so onerous and numerous that it may well be pronounced impracticable. Many roots of the tree would be broken and destroyed in delving around the base of the tree for the poisoned soil. The excavations around the trees would weaken their foundations, admitting large quantities of water from drenching rains, causing them to be easily blown over by the heavy winds. Procuring fresh earth might not be a difficult task; but where would you deposit the poisoned earth removed? If in a running stream, the water would be poisoned. If on the commons or highway, you would be prosecuted for a nuisance. If in your field or pasture, your livestock would be poisoned. If in an out-house, under lock and key, the ugly, dangerous mass would increase in dimensions from year to year; a constant source of watchfulness and anxiety.

Other objections could be stated, but these will suffice.

Another preventive measure suggested is to collect the drip, preventing it running down the trunk and settling at the base of the tree, where the rot first begins.

No device is mentioned to catch the drip. Large cloth bands could be used to absorb the portion that runs down the trunk; and this would be the greater portion.

Cloth spreads could be placed on the ground encircling the tree to arrest that which drips from the extended limbs. It is very evident that these are cumbersome remedies; the more so, when we reflect that they must be continued from year to year, and as often as you spray in the season.

When we consider the vast amounts of arsenical poisons, which can be measured by car-load lots, now stored away in the United States, the ultimate destination of which is our orchard lands, it is really discouraging. Yes, these millions of tons of poison are eventually to be dumped upon our orchard lands; there to mingle with and become a part of the soil.

It is imperative that we cast about for a new and more efficient remedy. So far as we are concerned with the codling moth, the apple maggot, the curculio, and all other insects that infest the fruit, it will be shown in the subsequent chapters, not only how they can be controlled, but exterminated. But there are diseases which

infest the leaves or bodies of the trees which can only be successfully combated by the use of some kind of arsenical preparation. The apple scab is a conspicuous form of one of these diseases. What we need is a spray that will control or eradicate these pests, without injury to the tree or to its fruit and foliage, and, if possible, fertilize the soil by its drip. This, indeed, would be an ideal spray.

CHAPTER XIII.

Cold Water Remedy.

The initial step that led to the discovery of this remedy, was the reflection that all living creatures that move upon the surface of the earth require a constant supply of air, as an essential to their existence; and that death must ensue, if deprived of air a sufficient length of time. The next question was of easy solution. Its application to the codling moth, in the simplest, cheapest, and most efficient way. A few experiments with the codling moth, in the larval form, developed the fact, that no apple worm, young or old, small or large, could survive an immersion in water, or any other liquid, for a term of forty-eight hours. But it must not be supposed that this successful experiment was arrived at, all at once. Several experiments of like kind but of shorter duration preceded it. About one-half dozen wormy apples were placed in a small tin can; then water was added, and a weight to sink the apples to the bottom of the can, the water standing three or four inches deep

above the apples. After a short time, the worms began to put out of their holes, to see what strange things were going on out of doors. One by one, a majority of them left their holes entirely, and sank to the bottom of the can; there they remained motionless and distended, apparently dead. After the lapse of six hours, by the clock, the water was carefully poured off, leaving the worms in the can. Each apple was then opened with a sharp knife, finding one or two worms, in the same condition, which were placed in the vessel with the others. After a few hours, all had revived. Similar experiments were performed with similar results. The respective times of the immersions being twelve, twenty-four and thirty-six hours. After the thirty-six-hour test, and a sufficient time having been allowed for revival, a large majority were found dead; one or two revived, but were too feeble to live; and out of the original number of twelve only two reported, ready for orchard duty. As already stated, the forty-eight-hour test was completely satisfactory.

It is advised that each orchardist should make tests of his own. He will then proceed with that confidence which arises from knowledge self-acquired. And the reason showing that the apple-grower who tries this remedy should make

his own experiments, is that the worm's power of endurance may vary with the climate.

The next most rational question which arises, is, How shall a sufficient quantity of worms be possessed to make a paying application of the remedy, and what expeditious arrangements shall be made? This can be done more easily than some may imagine. It can be done when the fruit is first thinned in the spring. All first-class apple-growers thin their fruit every year. Although the necessity of thinning fruit is a conceded question, yet a few good authorities will be briefly quoted. Prof. Bailey says, in *Field Notes*, page 58: "This practice of thinning fruit is a profitable one, especially in the instance of such heavy bearers as the Baldwin. If the tours of the orchard are frequent, the work of thinning is not burdensome." The professor also speaks of a drove of hogs following the operator, and assisting by eating the wormy apples.

In another place, in the same book, this professor speaks of thinning fruit as a necessity to profitable results.

From *Fruit Growing in Arid Regions*, by Paddock and Whipple, page 144: "Experiments have shown that it pays to thin apples. The fruit is improved in both size and color, the tree bears

more regularly, and those that might break under heavy loads are saved."

These last quoted authorities also speak of gathering the faulty and wormy apples and taking them out of the orchard to be destroyed. But in what manner? To be fed to the hogs and chickens, as is usually the case. The hogs and chickens, however, do not devour all of these faulty apples. It is a common thing to see waste apples lying around unconsumed, or partially so, in the hog pens and poultry yards. Or, what is still worse, the surplus is stored away in boxes and barrels to be used as occasion requires. Many worms, as a matter of course, mature under these conditions, and accept the opportunity to escape and spin their cocoons in adjacent places. So, when the actual effect is critically considered, this practice does not serve as a means of destruction, but of propagation. Results prove the correctness of this conclusion; for the worm is not on the decline, but the increase. Every year we read of new acquisitions being made to its ravages. Feeding to hogs, chickens or any other kind of animals, is a failure, as a means of destruction, and should be abandoned. One escaped worm, if not interfered with, is sufficient to stock every apple orchard in the world. Then, how quickly

can this be done, when by this practice, you allow them to escape by hundreds. In order to be as explicit as possible on this subject, and to avoid misconstruction, it is not claimed that hogs and chickens do not destroy the worms that they actually consume, but that many of the wormy apples are left untouched from which, as above explained, the evil consequences ensue. As a means of destroying the apple worm, it is better to abandon the practice altogether than to allow even one worm to escape.

We will now proceed to unfold a simple, cheap and efficient plan, within the reach of every apple-grower, which, if faithfully executed, will destroy every apple worm; and this means extermination. The bandage system, or rather device, has already been mentioned as a valuable adjunct in fighting the codling moth. While it is not absolutely essential, yet its use is recommended, which has already been explained. If used, the bandages should be placed around the trees during the last part of the winter, or the first of the spring, so as to be out of the way of the other work.

While spraying, in connection with the water remedy, is not positively necessary, still it is a powerful auxiliary and should not be omitted, in

case the orchard is badly infested. If the worms have just made their appearance or the orchard is lightly infested, it can be safely dispensed with. But, in the first case, where the worms, from previous indications, will be plentiful, give one good spraying. Then, if properly followed up by the water remedy, no more spraying will be necessary for this or any other season.

Spraying, when "thoroughly well done," prevents a large part of the first generation of worms from entering the apples. Under the water remedy, the worms of the first generation must have entered the apples before it can be applied. Then, if diligently used, it successfully prevents the attacks of any subsequent generation.

To begin; take one or two barrels of ordinary size, the number depending on the size of the orchard, and fill about half full with water and place at convenient distances in the orchard. A weight of some kind should be provided to sink the apples. This weight should be of such form and material that while it sinks the apples it, at the same time, renders it impossible for any worm to rise to the surface. Though this, as will be found, will rarely ever be the case. Screen wire, such as is used for doors and windows, is excellent for this purpose. Observe carefully

when the worms first begin their work. Do not be in a hurry; others will soon appear. The object is to get as many as possible of the first generation to work and fairly under headway before the attack is begun. Remember that each worm remains in the apple about three weeks before it matures. Now allow sufficient time to work over the orchard before the worms that first appeared have had time to mature. This, of course, will be within less than three weeks from the time of the first appearance of the worms. If the orchard is not worked over in this time, some of the older worms will mature, leave the apple and enter the cocoon state for the second generation. Conditions being favorable, select a sufficient force of careful and attentive hands, provided with sacks or baskets. If the rows are very long, a cart or truck, drawn by one or two horses, should be driven down the middles; and into the beds of these vehicles the sacks or baskets, when filled with wormy apples, could be very conveniently emptied; and from thence into the water barrels, following the instructions just given. If the trees are tall, each hand should be provided with a ladder. Each hand should take and confine himself to one row, in order to prevent confusion in the work and two or more hands look-

ing over the same apples. When the orchard is large, many hands will necessarily be employed, and a foreman should be appointed, who should not engage in, but, at all times, supervise the work.

Gathering the wormy apples and thinning the apples can be safely done at the first working, if the orchard is not badly infested with worms. But should the orchard be badly infested, it is safer not to thin to a stand until the second working; for you may pluck the very apple which the worm would assail, causing an attack upon the apples left for a stand. This would rarely occur after the second working, especially if the work was well done. Suppose, during the first operation, one sound apple is thinned from a cluster of three sound apples, leaving two for a stand, and on the second working it is discovered that an apple worm has entered one of these apples, necessitating its destruction and leaving only one for a stand. This caution may have the appearance of spinning out details with excessive minuteness; but when it is considered that this condition of things is happening in various parts of the orchard, causing unnecessary loss, the caution appears in its true light.

How many times should the orchard be worked

over? As many times, at least, as there are generations of apple worms in your section. The state of things in the orchard, ascertained by actual inspection, is the true guide to the number of times it should be worked.

All badly infested trees should be tagged, in order to readily distinguish them on the next working, when they should be given very careful attention. This will avoid all possibility of such trees becoming a nucleus for the spread of the codling moths.

As to the length of time the worms should remain immersed in the barrels of water, it is a convenient plan to allow them to remain in this condition until the next working. Then remove the apples and the worms, carefully examining both. All the worms will be found to be dead, which will renew confidence in this novel crusade against the worms.

A very convenient method of getting the worms out of the barrels is first to remove the apples, then pour the water in the barrel through a sieve into another vessel, the water being first well stirred; for the worms, as has been stated, lie at the bottom of the vessel. By this simple means, will be seen at least three-fourths of the

result of the operation. The remaining worms will be found dead in the apples.

The curculio and apple maggot are entitled to consideration with reference to this water treatment. Their habits will first be noted. The young apples are attacked by the curculio beetle, which has a long snout, with which it pierces or penetrates to the inside of the apple. At the bottom of the cavity it deposits its eggs, which soon hatch into larva. They remain in this state feeding on the apple four or five weeks. They then enter the pupal stage within the apple and remain two or three weeks longer, when they emerge from the apple, a full-fledged beetle, and hibernate in this form. There is but one brood each year. So the curculio remains within the young apple through all the different stages, from egg to maturity. Its entire stay in the apple consumes six or eight weeks. Every day of this time it is exposed to detection by the apple-grower. Could a better opportunity be asked for its capture and destruction?

Prof. Weed, in his work on Insects and Insecticides, has this to say of the apple maggot: "The adult of the apple maggot is a two-winged fly that appears early in summer and deposits eggs in the partially grown apples. These eggs are inserted,

one in a place, through the skin of the fruit. In a few days they hatch into maggots that tunnel the fruit in all directions, becoming full grown in five or six weeks, when they are whitish or greenish-white and about a quarter of an inch long. They then leave the fruit, and generally go into the soil an inch or less, where they change into the pupal state. They remain in this condition until the following summer, when they emerge as flies again." The professor also says: "The only thorough-going remedy is that of destroying wind-falls." It will be noted that as this insect remains in the apple five or six weeks an excellent opportunity is afforded for its capture.

Not being troubled in this section by either of these insects, no precise rule can be given for the destruction of either, by drowning. Those who are bothered with this pest can easily determine this point by a few experiments.

In going over the orchard, gathering worm-infested apples, care should be taken to gather all fallen apples. Not a single one should be left. They are pest-breeders.

CHAPTER XIV.

Hot Water Remedy.

A quick method, but somewhat more expensive, yet deadly sure to destroy all insects that penetrate or adhere to the apple, is what may properly be called the hot-water-method. Place a caldron at some suitable place in your orchard, partly filled with water, and heat to the boiling point. Into this boiling caldron empty the worm-infested apples and let them remain until the apples are of the same temperature at the core as the boiling water, or until they are nearly cooked. It is self-evident that this remedy is all sufficient to kill, in a very short time, any conceivable form of insect life. The writer has tried it repeatedly on the apple worm. The worms never leave the apples, but die distended where the heat overtakes them.

The question of expense is about all, and this is a mere trifle, to determine the adoption of the one or the other method. All that has been said so far on this water remedy applies to the young and growing apple.

Here it may be remarked that this remedy,

especially the hot water remedy, applies to any other fruit or vegetable equally as well as to the apple.

We now come to gathering the apple crop, which is the most important phase of the subject. If no active measures have been taken against the enemy up to this time, still he can be exterminated at this late stage by the water remedy alone, if judiciously applied. In the last generation of worms are generally all the preceding generations. So, if you destroy this last generation, there can be no subsequent generation. Now, there is a time in the fall of the year when the whole of the codling moth family is in the form of the apple worm, and all these worms are in the apples. In this state of things, the part the orchardist is to play is quite clear: He must gather the wormy apples before the worms mature and leave the apples to enter the cocoon state, to mature the following spring. How, in the opinion of the writer, to best effect this purpose will now be explained. No extra preparations, with two exceptions, need be made, and these are very simple ones. One is the water barrel, which should be placed near the apple stand where the apples are graded, boxed, etc.; the other is an extra sack, or, what is more convenient, the divi-

sion of one sack into two compartments, one for the good and the other for the bad apples. The good apples should, of course, be placed on the stand or other convenient place, the bad ones into the water barrels.

If the worm-infested apples are numerous, the cold water method is preferable, as these apples, when the worms are drowned, can be put to some useful purpose. But if the wormy apples are scarce, as will surely be the case if the preceding work has been well done, it is best to make short work of them, by casting them into the boiling caldron. In order to make a clean sweep, there should not be a single apple left on tree or ground.

In no event, should a wormy apple be boxed or carried to the cellar, for this means propagation and consequent dissemination. And why should you wish to do either? Yet, it is the common practice to dump the wormy apples in the cellar, as though we wished to preserve the breed.

The caution to have the doors and windows well protected with screen wire is good; for, in case, by accident or negligence, a wormy apple is carried to the cellar, they will afford an opportunity to capture the moth in the spring.

Those who are inclined to think this process

too tedious and laborious, should be reminded that with very little additional labor every apple in the orchard, though they should run into the millions, is, or should be, handled by human hands and gazed upon by human eyes. Then, while so doing, why not separate the worm-infested apples from the sound ones, just as you separate the small apples from the large ones in the process of grading? There is really more profit in the first case than in the last. The additional labor referred to is not leaving any apples on the trees nor on the ground.

In the Northern states, and in Canada, where there is only one generation of the codling moth to the season, it could be overcome by this method alone with very little trouble. Further South, where there are two and three generations to the season, more difficulty will be experienced; consequently, more care and energy should be used.

It will likely be asked, why not use some liquid stronger than water? Why not use coal oil, carbolic acid or vinegar? Simply because water is cheaper and at the hands of all. Every cent added to the cost of production diminishes that much the profits of the apple crop. The

most desirable remedy is that which is cheapest and most efficacious.

Now, a word of caution to those who have not been visited by the apple worm. Do not fancy, as some have done, that because you have escaped thus far the codling moth will never pay you a visit. Under existing conditions, there is no way to keep him out of your orchard. The means of dissemination are too numerous and uncontrolled. In fact, at present, free license is given to raise them at will and scatter them to the four winds.

It is much easier to check and destroy the worm on his first entrance into the orchard than to oust him after he has once established a colony. To prevent the founding of this colony of codling moths among the trees, you should be on the alert. It is easily done. All that is required is a little forethought, followed up by prompt action. At apple gathering time, or at thinning time, provide each hand with strips of cloth, to be tagged to each tree on which the apple worm, or any sign of the codling moth, is first discovered. Instruct the hands to report these facts immediately. Proceed to the tree at once, examine the supposed infested fruit of this tree and all the apples on it and on those for a

considerable space around. If the worms are really there, use every possible precaution, even if it amounts to stripping the infested tree and the neighboring ones of all their fruit. Spray thoroughly and keep a close watch on this locality throughout the entire season. Do the same on the following season. Should the discovery be made in the fall at gathering time, spraying will not be necessary at that time, but it should surely be well done next spring. All that can be done at this time is to scrutinize the fruit of this tree and neighboring ones very carefully and see that the tree is well tagged for identification the following spring. As a still further precaution, the apple-grower might, if he so desires, set these suspicious apples apart from the rest, in order to undergo a second and double scrutiny. So much particularity on one point may indeed excite a smile, but had the writer taken his own advice he would have saved much trouble and expense. Is he the only one who has reaped the fruits of his negligence?

As regards the management of the bandages, sufficient directions have already been given. These bandages will serve as indices to the character of the preceding work. When many worms or cocoons are found under them, their use should

be continued, and your dilligence renewed; for you may know that the first working-over was imperfectly done. In this case, you have been guilty of negligence in one or two particulars. You either began the work so late that many of the wormy apples had fallen, from which the worms emerged and sheltered under the bandages, or the gathering was so carelessly done that many of the worm-infested apples were left behind, from which the same results naturally followed.

If, on examination of the bandages, you should discover no worms, it is clear that the gathering process has been thoroughly done, and their future use may safely be discontinued, thus canceling this item of expense.

On the subject of careless work, it is useful to observe that the hands should be required to work the rows of trees in strict numerical order. By this means, each hand would have, throughout the entire work, either an even or an odd row, and by counting the rows you could very readily ascertain the party who had been guilty of negligence.

CHAPTER XV.

Codling Moth-House.

Another device which could be very successfully and conveniently used, is what may be properly termed a codling moth-house. To prepare such a building, construct a wooden frame, in the form of a square, or in that of a right-angle parallelogram, about 7 or 8 feet high and as long and as wide as the exigencies of the case may require. Floor and cover neatly. In the ends and sides, about six feet from the floor, place glass windows. Near the top, in the side or end of the building, make an opening about 12 or 18 inches square. In this opening insert a box, open at both ends, two or three feet long. The inside end should point obliquely towards the floor of the building. Near the middle, or the inside of the box or channel, should be placed a valve; and so constructed, that the weight of the apples, when poured into the outer end of the receptacle, would lift the valve, letting the apples fall on the floor below. The apples having passed, the weight and inclination of the valve cause it to close down to its proper place. To enter this

house as occasion may require, there should be two doors, an inside and an outside door. The inner door should be several feet from and opposite to the outer door. The space between should be walled up and the top covered. In the hall thus made there should be sufficient space for one or two persons to easily move about. Both doors should open on the inside, having glass windows in their upper halves. The house is now complete and ready for use. The size of the house should, of course, correspond to that of the orchard. All the parts should be so closely fitted together as to preclude the possibility of escape of worm or moth.

When infested apples are put into this house, during the spring or summer months, the larva will soon mature into moths, which will immediately begin to flutter against the windows, where they may be readily seen and destroyed. On entering the house to kill the moths, or for any other purpose, care should be taken to prevent the escape of the moths. On entering the house, the window of the outside door should be carefully examined before opening to see if perchance any moths should have gotten into the hall; this, however, should never be the case. If it should occur, you may know at once that the

hall is not properly constructed, and you should immediately repair the defect. Once in the hall, close securely the outside door. In like manner, proceed with the inner door to the main floor of the building, where you can destroy the moths at pleasure. When you leave the building, carefully close the inner door, then examine the windows of both doors and the sides of the hall, destroying any moths that may be discovered in the hall. You may then safely leave the hall, closing the outside door. Not more apples than are required for immediate consumption should be taken out at one time. By this means, any immature worms may be readily detected and destroyed. In fact, this should always be done, in whatever form the insect may be when discovered. If fed to hogs, not more should be given than they will ravenously consume. Never should one be left on the ground, for reasons too obvious to state.

It is not absolutely necessary that you should enter the house to destroy the moths, for being short-lived they will soon die in their confinement.

When the apples are put in the house during the fall months, the larva will leave the apples as in the summer months, and enter into the cocoon

state on the sides of the building, but will not evolve into moths until next spring. The apple-grower may then enter and wreak his vengeance on his direst enemy, or leave them alone to die of inactivity and want of business.

However, the larva may be forced into premature development in the dead of winter, by raising the temperature as explained under the head of Winter Remedies.

CHAPTER XVI.

Dirt Remedy.

Another novel remedy which may be successfully used to overcome the codling moth is what the writer is pleased to call the Dirt Remedy. Like the Water Remedy, it is cheap and at the hands of all.

Dig a trench about two feet deep and three feet in width. The length should be sufficient to hold the estimated quantity of infected apples to be treated. The bottom should be smooth, the sides and ends perpendicular. Over the bottom spread a layer of wormy apples. Over this spread a layer of dirt, about five or six inches deep. Press down firmly with the feet, leaving no air pockets, and so on until the trench is filled, the last layer should be pulverized dirt. The last layer of apples should not come to the top of the trench. Now cover with dirt, in considerable quantities, and be sure to press down very firmly.

In due time, the worm will mature, and leaving the apple weave its cocoon, formed of a mixture of dirt and fibre. The cocoon formed under these conditions is a dirty, spongy mass and much

larger than that woven by the worm when unmolested. Next, the moth is evolved; and, being surrounded completely by dirt, it is perfectly helpless and soon perishes.

If loose dirt is left over the excavation, the worm will work upward to the surface, and thus escape.

Some difficulty may be experienced in sandy soil, owing to its loose nature, and consequently additional labor to give it sufficient compactness to hold down the worms.

Sure death as this remedy is to the codling moth, yet it should not be resorted to if there is any intention of using the infected apples. For, as before observed, the cocoon under this treatment is formed partly of dirt and resembles very much a small lump of dirt, so much so that it would evade detection from the inexperienced eye. So, in removing the dirt to get the apples, you would unavoidably throw many of the cocoons to the surface, where in due time, unnoticed, they would develop into moths. We will now show how the difficulty can be very easily and beneficially obviated. Dig a trench, or make an excavation in the ground, somewhat in the form of an ordinary grave, of any size or length that you may see proper, only the offsets should

be nearer the surface than in those of the grave. You will thus have a trench within a trench. Now begin to fill the inner trench at one end with infected apples, until the apples are near the upper edges of the trench. Each batch of apples should fill that portion of the inner trench into which they are emptied, so they can be covered before going after the next load. Over the deposit thus made, spread a piece of cloth, completely covering the apples and tucked down at the sides and end in grooves made for that purpose. Allow the cloth to extend a little beyond the deposit of apples and rest on the bottom of the inner trench. Over the cloth place plank, closely fitting and extending as far as the first deposit of apples; then cover the plank, covering well with dirt, and so on, until the trench is completely filled and covered, from end to end. The cloth may be cut into strips to correspond to the length of each batch, or it may be of the whole length of the trench. Cloth of a dark color is best, as the contrast formed by the cream-colored cocoon that is soon to be placed thereon will cause it to be more readily distinguished.

Never take more apples from the excavation than are intended for immediate use. Remember there are in these faulty apples worms of all ages

and sizes, and that it takes this worm from three to four weeks to mature after it has entered the apple. Of course, if the apples are taken from the trench and left for a considerable time in exposed places, the young worms on maturing will leave the apples and hibernate in or near the orchard, and this means trouble in the spring.

To remove the apples, begin at one end of the trench, and if any worms are seen destroy them; roll the cloth, having the lower side within the roll; put the plank on the outside of the trench for future use. On leaving the trench, cut off evenly the cloth to the extent of the apples removed, leaving five or six inches of the cloth resting on the bottom of the trench and covering the apples behind it; then fill up well with dirt the opening made in taking out the apples. The strip of cloth cut off should remain rolled and immediately burned.

At least a month before the pupas begin to develop into moth in the spring, the apples should all be removed and consumed, the cloth all burned and the excavation well closed with packed dirt. This last operation will effectually prevent the escape of any moths that may have developed from pupas left by chance in the bottom of the excavation.

CHAPTER XVII.

Pruning, Auxiliary Remedy.

It is not the writer's intention to enter into the subject of pruning generally. It may be said briefly that an orchard tree can be so pruned as to serve several beneficial purposes. And happily all these beneficial objects can by the skillful operator be made to combine into one harmonious whole. Such a tree should not be too tall. The fruit, in gathering or trimming, will not need the use of long and cumbrous ladders. The extending limbs will not be so close that large quantities of fruit will be knocked off in the act of gathering. Standing on the outside, can easily be distinguished the perfect from the imperfect fruit, facilitating the handling of the fruit for whatever purpose. A tree so pruned may be aptly styled the perfection of the pruner's art; and in gathering wormy apples for the water treatment, the work would be greatly facilitated. In many cases, the worm sign on an apple can be distinguished at a distance of thirty or even forty feet. Care should be taken in shaping the

young orchard to make easy both vision and approach. Old orchards could be vastly improved in this respect, but it should not be attempted only by the most skillful operator; for an old orchard, once out of shape, generally remains so.

CHAPTER XVIII.

Winter Remedies.

A treatise of this kind, the principal object of which is to show how the codling moth can be exterminated, would be incomplete, did it not dwell on the remedies that may be employed during the winter months to accomplish this end.

This portion of the subject may be very appropriately divided into three different heads: Treatment of the soil, the trees, and an increase of the temperature to prematurely force the development of the codling moth. We have already observed that the codling moth sometimes enters the pupal state in the soil of the orchard, instead of ascending the trees for this purpose, and that a large majority of the apple maggot family pupate in the soil near the base of the trees. Now, the object should be to break up their winter quarters, force them out, helpless and unprepared, to perish from the severity of the weather or to be devoured by rapacious birds. To effect this purpose, the writer uses a widespread two-horse cultivator, carrying eighteen spring teeth, with which he rapidly sweeps over the orchard, plowing in cross-wise directions. When, judging from the condition of the weather,

these orchard pests are snugly housed up for the winter, the harrow or cultivator should be used over the orchard. Follow it up by two or three additional stirrings during the winter. The more the soil is stirred and tossed about, the less the probability of survival until the spring sets in. In addition to this wholesale wreckage of the pupas, you have materially improved the condition of the soil.

After this cleaning up downstairs, let us proceed upstairs after the codling moth. In fact, we must follow him wherever he goes with deadly purpose, well put into execution. Push him, push him, summer and winter alike! Allow him no peace. What else can he expect? He is an intruder in our orchards, lives on another's labor, and appropriates our goods without our consent.

We have learned that he hides in the winter months under the rough bark of the tree, in its crevices and holes. All these indicate their simple and appropriate remedies. Rub off the bark, leaving the branches and trunk smooth. If this is well done, all the bark and cocoons will fall to the ground. If any of the cocoons escape your observation and adhere to the trees, they will fall an easy prey to the birds, as will also those on the ground. Fill up the crevices and holes with

putty or paint to an even surface with that of the tree. This filling will last for several years, or until the growth of the tree closes over the holes and crevices. It serves more than one useful purpose. It safely imprisons any insect concealed therein; prevents the entrance of dampness, causing decay and fungus growth, and effectually closes up a favorite hiding place for insects in the future.

It is a fact, well known to many orchard men, that the codling moth is more abundant in the spring when the winter was hard than when mild. For a while this question was puzzling. The proper solution appears when it is remembered that cold weather retards, while warm weather hastens, the development of the codling moth. As a consequence, a severe winter holds back the development until the spring is fairly open. On the other hand, the warmth of a mild winter would prematurely force the development of the moth, when it must inevitably perish before spring from lack of means of subsistence and the recurring spells of freezing weather. These facts suggest the idea that by creating an artificial heat in the orchard during the winter months, all, or nearly all, the pupas could be forced to evolve into the moth state, and then be

destroyed. The required temperature could be raised by the use of smudge pots, in the same manner as orchard heating against the frost, or by log fires in those regions where timber is abundant. Nature could be made to assist in the operation by applying the artificial heat during the warm spells of winter. Thus, by combining nature with art, the expense of applying the latter would be much reduced. Indian summer would afford the most favorable opportunity in those states that have this kind of weather. And as this peculiar phase of weather is periodical, and its duration regular, timely arrangements could be made to have the artificial heat run with the whole of the warm spell. Very little raising of the temperature would be required through the day. Nature would supply nearly all the warmth needed during the day time. But at night, it seems, the temperature should be kept uniformly with that of the day. By this means, the development of the moth would be rushed, and, as a consequence, a very large majority of them inevitably destroyed.

But this remedy is not confined to the orchard alone. There are good reasons to believe that it can be successfully applied in those cases where worm-infested apples have been stored in

out-houses or in cellars. The mode of application is almost too evident to be mentioned. The screen doors and windows have already been mentioned. Exclude, as far as practicable, the outward temperature. Apply the heat, carefully regulated by the assistance of good thermometers. As the moths develop, kill them as they flutter against the screen fastenings, or drive them out into the bleak winter to perish.

As a guide to the length of time the heat should be kept up in the orchard or in the cellar, remember that it is about twenty days from the spinning of the cocoon to the development of the moth.

There are two objections that can be urged against this mid-winter operation in the cellar. Both of which, are without solid foundation. One is this, the heat will cause the fruit to mellow and decay—not all of it. And of what value is this partial loss of fruit compared to the benefits derived from the wholesale slaughter of the codling moths?

As another objection, it will be claimed that the moth will naturally develop in the spring, and can then be easily killed against the screen doors and windows. But what are the actual conditions in the spring when the moths first be-

gin to appear? There are three or four weeks difference between the appearance of the first and last moths of the first generation. During all this time there are daily visits to the cellar by home-folks, children, strangers, visitors and traders. So the doors are frequently opened, sometimes left open, allowing the moths to escape to the orchard. Under the winter-heating remedy, the conditions are entirely different. If the moth remains in the cellar, as has been pointed out, he is easily killed; if he escapes, it is to meet death from cold and starvation.

CHAPTER XIX.

Legislative Remedies.

It is clear, beyond dispute, to any one who has paid attention to what has been said in the preceding chapters, that the remedies recommended, if diligently applied, will work the extermination of the codling moth in a given locality. But this particular locality in which the moth has been overcome must be protected from future incursions, else the victory is only of a temporary nature, and the battle must be fought over again. The same applies to districts, counties, states; yes, to the United States. Effective measures must be taken, and rigidly applied, to prevent the spread of the moth from the infected districts into those that are not infected; and these districts must be so extensive as to embrace the whole United States. This prevention can be effected only by legislation of a prohibitive character. The codling moth must be confined to the orchards which present the scene of his depredations, until the owners of these orchards, driven to extremities, rise up against him, resolved on a war of extermination. It is impolitic and unfair,

utterly so, that the dilligent man, who clears his orchard of these insects, should have them forced upon him, year after year, by his indolent neighbor. This indolent orchardist can, and should be compelled by appropriate legislation, to keep his pests at home. A man has no right to turn a herd of swine into his neighbor's cornfield; neither has he a right to overrun his apple orchard with codling moths. What prohibitive legislation, then, is it wisest to adopt?

Let each state pass a law, making it a misdemeanor, with a suitable penalty annxed, for any apple-grower or any other person to sell, give away or in any manner to remove any worm-infected fruit from such worm-infected orchard. In addition, the violator of this law should be made liable to an action in damages. In shipping fruit, apple-growers should be required to lable the apple boxes or barrels with their names and postoffice addresses, so that in case of a violation of the law the guilty parties could be readily traced.

The states should also pass suitable laws to prevent the importation of worm-infected apples into their borders.

The Congress should be induced to make it a violation of federal law, under its inter-state com-

merce jurisdiction, to ship or transport worm-infected fruit from one state into another; the same or similar provisions should be made to apply to the importation of wormy fruit from foreign countries into the United States.

This legislation, it seems, could be brought about by the assistance of our fruit associations and that of our leading and influential fruit-growers; many of the last mentioned are now in Congress.

When such legislation is secured, foreign nations, seeing its salutary effects, will gladly imitate our example.

There will then be a general and permanent quarantine against the codling moth and kindred pests.

CONCLUDING REMARKS.

Referring to arsenical poisoning for the codling moth, we will say that spraying with it is, at best, only a partially effective remedy, and can never be relied on for its eradication. The fact may be recited that, after twenty-five years or more of popular use, the codling moth is now more numerous and extends over a wider area of the United States than ever before. And there are well grounded forebodings that it will still further extend its depredations.

When we reflect upon the vast sums of money annually expended for these sprays, and the means of their appliance, and the amount of absolutely worthless sprays upon the market, and that, after repeated sprays, the worms seem to increase rather than diminish, we are deeply impressed with the necessity of finding a more efficient remedy. Our aim should be, not simply to control the codling moth, but to utterly exterminate the breed. In this way only can there be a permanent end to the unceasing labor and expense of fighting with half-way remedies.

After the first discovery of the introduction

of the codling moth into this country, had the legislation then been passed which is recommended in this treatise, the moths would have been confined to the localities of their first appearance, until means could have been devised to have stamped them out. As this prohibitive legislation would have worked well then, so it must be made to work now. It is in vain that search be made for means to eradicate this insect, if, while it is eradicated in one place, it is spread in another. When prohibitive legislation seconds the means of extermination, the codling moth will be as an evil once endured, but now no more.

APR 26 1913