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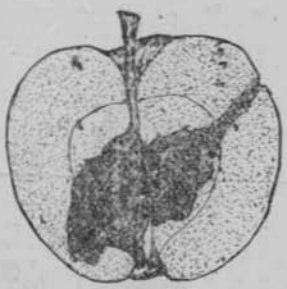

The Codling Moth

BY J. M. ALDRICH

MOSCOW
MIRROR JOB ROOMS
1900

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Bulletins.

The regular bulletins of the Station are sent free to all who request them. Bulletins issued since the close of the fiscal year, June 30th, 1898:

16. The San Jose Scale in Idaho.
17. Construction and Management of Hotbeds.
18. Sugar Beet Investigations in 1898.
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20. Apple Scab in the Potlatch.

THE CODLING MOTH.

By J. M. ALDRICH.

Wherever apples are grown on a commercial scale, the codling moth soon becomes a serious problem. The ease with which the insect introduces itself, and the difficulty, not to say impossibility, of finding any complete remedy for its depredations, make it easily chief of the apple-grower's troubles.

Until recently, owing to the newness of the orchards about Moscow, it has been almost impossible to carry on any connected experiments against it at the Idaho Experiment Station. Even the work of the past year was performed at a distance of 30 miles from the institution. The prospect now is that hereafter all the opportunities desired will be at our doors, the pest having thoroughly established itself in the last year in the so-called Palouse country.

The present bulletin is general and somewhat preliminary in character, no report on the insect having been published in the State. The results of various experiments are set forth, as far as they have yet shown any facts of importance; but no great originality can be assumed for the general discussion of an insect that has been studied by nearly all the economic entomologists of the United States. The bulletin of Professor Slingerland (Cornell Agricultural Experiment Station, No. 142), has brought together all the known facts about the insect, with extensive additions, and from an eastern standpoint almost exhausts the subject. This and the Oregon bulletins have been consulted, and many horticulturists in Idaho have contributed items of importance, especially Mr. A. F. Hitt, of Weiser, and Mr. A. McPherson of Boise, both eminently practical and suc-

cessful horticulturists. A large part of the detailed investigations reported herein are the work of Mr. Louis A. Turley, who also made the pen drawings for the illustrations. My acknowledgments are due for the assistance mentioned.

Present Status in Idaho.

The codling moth has been known in the Clearwater valley since 1887, and in South Idaho for nearly as long. There is no section of the state that has been producing apples to ship for any length of time that is not infested. The newer orchards, especially if remote from older ones, are still more or less free, but the spread of the insect by natural means is quite rapid, and it cannot be expected that any locality will long be immune. The sections from which the main shipments of apples are made may be said to be fully infested, and will probably become no worse than they now are. When it is stated that in neglected orchards in the warmer arid parts of the state, the per cent of wormy apples not uncommonly reaches 90 or more it will be seen that matters could not be much worse. In an untreated orchard at Moscow the past November, 40 trees, bearing 8200 apples, were carefully examined, and 21 per cent of the fruit found to be wormy. This in a section where the worst damage hitherto was probably 5 per cent. These facts show the absolute necessity of applying the best known means of defense, which will undoubtedly, though at some cost in labor and attention, reduce the loss to a comparatively small fraction.

Habits.

The moths emerge in May, at least a week after the blossoms have fallen from the apple trees, and some of them considerably later. They deposit their eggs singly on the young apples, and not rarely scatter them about on the foliage also. The eggs are small, difficult to find, whitish in color, and hatch in a few days. The young worm is extremely small. It makes its way to the fruit, if not already upon it, and begins active business by boring into the skin. Once under this protection, it can bid defiance to spray or anything else until it is full-grown. It is a

common habit of the first brood, however, to enter the apple in many instances at the calyx or blossom end, in which case it feeds for a time upon the remains of the blossom before entering the flesh. Upon this peculiarity of habit most of the success of spraying depends. It requires about a month for the worm to reach its full size, the exact time depending much on the warmth of the season. When full grown, the worm emerges from the apple and seeks a shelter for the period of transformation into the moth. Crevices of the bark seem to be instinctively sought, but in the absence of these, the worm will enter cracks in the ground, or any similar refuge. Here a delicate cocoon is spun and the insect passes into the pupa state, losing its activity and remaining motionless. The length of this stage also depends greatly on temperature. In South Idaho under favorable conditions it may be less than six days, according to Mr. McPherson's observations; but it is usually a week or more. The moth

FIG. 1.

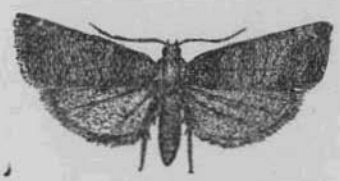

FIG. 2.

FIG. 3.

emerges, more eggs are laid and the cycle repeats itself. The later broods, however, do not enter the apple at the calyx, or very rarely do so, usually commencing to excavate at the first available point, as it would seem. The number of complete cycles in a year is spoken of as the number of "broods", and has a very direct influence on the total damage done. This one ele-

ment makes all the difference between the comparatively small damage done in the northern parts of the East and the terrible ravages from which the warmer parts of our state suffer.

The adult insect, or codling moth proper, is nocturnal in its habits, and is rarely seen in an orchard, even by close observers. On this account, I give three figures of the insect (Figs. 1, 2 and 3). These will suffice for its recognition, especially if some coppery reflections in the dark oval at the end of the fore wing are noticed. It is a very simple matter in summer to confine a few full-grown worms under an inverted tumbler and rear the adult. Every orchardist should try this easy way of learning what his enemy looks like. As the moth is not at all attracted to lights, the oft-proposed method of catching them at night is wholly useless. Doubtless many moths will come, but the kind wanted will not be among them.

Number of Broods.

As before stated, this is the element that determines the amount of damage suffered in any locality. As the time required for the insect to pass through its various stages depends upon warmth more than anything else, it follows that the warmer sections will have more broods, and hence more damage, than the cooler localities. Within our state there is considerable variation in this regard, but the subject is far from thoroughly studied yet. In the section from Boise to Weiser, and about Lewiston, there are at least three broods, and part of a fourth was observed at Boise this year.

In Latah county there are two full broods and part of a third. The past season the third brood did not begin to enter the apples until about October 5th in the Potlatch section, about Kendrick, and October 10th at Moscow. These late worms in most cases died before they had penetrated far beneath the skin of the fruit. As a consequence, there were many apples in the market like figures 4 and 5, with slight blemishes, scarcely extending below the skin, and hardly looking like the work of the moth at all. It is something of a question whether earlier picking of the winter ap-

ple crop would not have saved a great deal of this damage. Last year the season was unprecedentedly late in Latah county, and it may be assumed that in ordinary years the third brood will appear a little before October 1st.

In November, 121 apples having the small marks of the third brood of the moth were selected from a Moscow orchard, and examined to see how many living worms they contained. The number was just 20, showing that five-sixths of the brood had

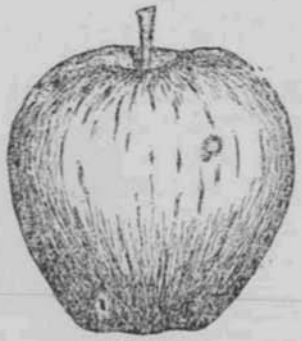

FIG. 4.

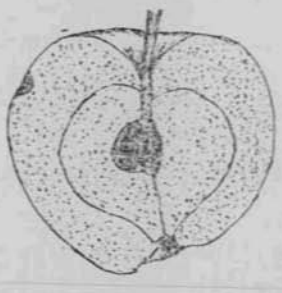

FIG. 5.

died. If this should be the regular experience in the county, it will certainly have a marked effect on the prevalence of the moth, but the late season and the cold period about October 14th no doubt combined to produce a very unusual destruction of the worms.

In Fremont and Bingham counties, the high altitude and shorter season will be very likely to reduce the broods to two; but the worms are so rare there at present that the point cannot be determined.

In the vicinity of Paris, Bear Lake county, at an altitude of 6,000 feet, there are a few worms, and the number of broods could no doubt be ascertained by anyone who would take the pains to band a few trees and record the number of worms caught each week.

In general, we may say that there are three broods in Idaho.

In eastern states of the same latitude there are only two, and the second is frequently late and partial. This fact should be kept in mind in seeking to apply eastern methods to Idaho orchards, since the conditions are very different.

Remedies.

SPRAYING.—On May 25 and 26, within a week after the blossoms fell, we sprayed part of a mixed orchard of ten-year-old trees at Juliaetta. Paris green was used, applied in Bordeaux mixture, as some experiments for scab were carried on at the same time. The results of considerable work at other experiment stations warrants the assumption that the effect of the Paris green would be produced as if it had been in water. On both days there was some rain after the application, which no doubt reduced the benefit of the spray to some degree. The poison adheres better in Bordeaux than in water, however, and it is probable that the rain reduced the effect but little.

On June 19 there were still no signs of the codling moth, but on July 1 the first brood was well at work. On this date and July 7, careful examination was made to answer the following questions:

What is the average number of wormy apples per tree where sprayed, and where unsprayed?

Of the wormy apples, what proportion are entered at the calyx, and is the proportion the same on sprayed and unsprayed trees of the same variety?

The following tables show the answers, for two varieties:

VARIETY.	CONDITION.	No. Trees.	No. Wormy Apples.	No. Entered at Calyx.	Per Cent at Calyx.	No. Wormy per Tree.	Saved per Tree.	Per Cent Saved.
Duchess	Unsprayed.	3	89	39	40	29.6		
	Sprayed.	7	114	15	12.4	16.3	12.3	41.2
Winesap	Unsprayed.	2	61	25	41	30.5		
	Sprayed.	1	18	2	11	18	12.5	41

FIG. 6. TREE BANDED FOR CODLING MOTH.

It will be noted that the per cent saved, as recorded in the table, is not figured on the total crop of that variety, but is a per cent of the wormy apples affected by the first brood. Without further treatment, it might happen that these saved apples would largely be destroyed by fall.

The close correspondence of results in the two varieties is very remarkable. As the figures were not tabulated till November, it was not observed until that time.

The second question above is answered in a striking manner. It is clear that most of the worms destroyed were entering the calyx. In the Duchess, if we analyze the figures a little farther, we find on unsprayed trees an average of 16.7 worms entering the side of the apple; on sprayed trees, an average of 14.2 worms, or a difference of 2.5, representing the number of apples saved from these worms. Therefore out of the total saving of 12.3 apples per tree, it appears that 9.7 were saved from the original 40 per cent of worms that would have entered the calyx, while only 2.5 apples were saved from the original 60 per cent that would have entered the side. Or commencing anew with our figures, we can easily show that 15 per cent of the worms entering the side were destroyed, and 83 per cent of those entering the calyx; that is to say, the spraying was over five and a half times as effective on the worms entering the calyx as on those entering the side. The figures on the Winesap yield a result even more emphatic; of the worms entering the side only 11 per cent were destroyed, while of those entering the calyx, 81 per cent perished; so that the effectiveness of the spray was over seven times as great in the latter case.

It may be that the rains washed some of the poison off the sides of the apples, while that in the calyx was undisturbed, and thus the difference comes out somewhat too strongly; but there can be no doubt that a great difference exists.

Of course to the fruit grower it makes no difference whether the worm is killed in one place or another; but the figures bring out one of the principles of spraying for the insect. The main

point is that the spray must be put on while it is yet possible to get it into the calyx cup. After the blossom falls, it is only a few days until this becomes closed by the turning in of the little green leaves (sepals) just outside the flower. When this occurs, the time for effective spraying has gone by, since the poison cannot be placed in the one spot where the worm will be likely to eat it. It may be that the worms will not make their appearance for three weeks after the spraying-time, but the poison is there waiting them, and cannot fall out or be washed away.

In order to have some exact figures on the length of time that different varieties of apples remain in condition to spray, a series of observations was made last spring on all the varieties accessible from the experiment station. The results follow:

Pewaukee	Blossoms Fell June			17;	Calyx Remained Open			6	Days.
Spitzenberg	"	"	"	18	"	"	"	6	"
Red Astrakhan	"	"	"	17	"	"	"	7	"
Whitney No. 20	"	"	"	16	"	"	"	7	"
Wealthy	"	"	"	15	"	"	"	7	"
Yellow Transparent	"	"	"	14	"	"	"	8	"
Mann	"	"	"	16	"	"	"	8	"
Ben Davis	"	"	"	16	"	"	"	10	"
Gravenstein	"	"	"	16	"	"	"	10	"
Blue Pearmain	"	"	"	14	"	"	"	10	"
Strawberry	"	"	"	14	"	"	"	10	"

The dates would probably be three weeks earlier in an average season.

Whether it pays to spray more than once is a question that has been much discussed, and considerable evidence may be adduced on either side. Some experiments at Juliaetta last spring were intended to have a bearing on this question, but they fell through because the trees could not be examined at the proper time to determine the results. Our small success in destroying worms entering the side of the apple would argue against the value of later spraying, since nearly all worms of the later broods enter that way. However, some reports of good results have been

placed on record. The subject deserves further investigation.

BANDING—This consists in placing one or more bands of cloth about the trunk of the tree, to give the worms a place in which to spin their cocoons. Before they have completed their transformations, the band is taken off and the worms destroyed, after which it is replaced to capture later worms in the same way. It would seem hardly necessary to mention the fact that unless the bands are removed regularly and the worms destroyed, the process is a benefit to the insect; but so many reports have come to my attention of orchardists neglecting the bands, that I wish to emphasize this point. As before stated, the full-grown worm leaves the apple and seeks a protection, under which to construct its cocoon and transform to the moth. Nature seems to have given the insect the instinct to seek crevices in the bark of the tree. In young trees, or in old trees that are well kept, these do not exist; then other protections are sought out. Sometimes cracks in the ground are utilized. The worms will crawl considerable distances to find a suitable place. It has been found that a band or two of some soft cloth will prove so attractive to the worms that by far the larger part will lodge there.

As the moth develops in hot weather in a week or a little less from the time of making the cocoon, the bands must be examined once a week during the middle of the summer. In the warmer arid parts of the state, once in six days is considerably safer while the hottest weather lasts.

The usual method of attaching a band is to make it long enough to lap a little, and drive a tack through the ends into the bark. This is removed and replaced each time the band is examined. A much more convenient method, used by Mr. M. J. Wessels, of Kendrick, and I think invented by him, is to drive a brad into the bark where the band is wanted, pinch off the head, and simply press the band down over this. The brad is never removed, and much time is saved which would otherwise be spent in searching for tacks dropped on the ground, etc.

On the subject of material for bands, considerable difference of opinion exists, each grower generally believing his own method

best. In my experiments, reported below, the bands were of brown Canton flannel, four inches or a little more in width, doubled so that the soft surface was both on the outside and against the bark. Two were placed eight inches apart on the trunk of each tree. Burlap is often used. The worms will collect more or less under almost anything, even twisted hay being used in some places. The object ought to be to use the very best method, so as to collect if possible all the worms, and the small additional expense of using Canton flannel I believe to be a good investment.

There seems to be more in the banding method than the reports of experiments in other states would indicate, or else it works better in this state than elsewhere. Prof. Washburn reported in Bulletin No. 10 of the Oregon experiment station, a total for the season, commencing Aug. 1, of 204 worms collected under bands on 8 trees, or an average of 25½ worms per tree. On 40 trees at Juliaetta last summer over 200 worms per tree were collected by us in the season. The highest record for one tree was 494 not counting one week when the record was lost. To show that these results are not exceptional, I may mention a few that have been given to me from reliable sources.

Inspector R. M. Gwinn assisted a farmer in Canyon Co. to count and destroy the worms under bands on 19 trees. These were banded with wide strips of thick cloth from an old overcoat. The first tree gave 190 worms, the second 196, and the smallest yield in the 19 was 175 worms!

Mr. Taylor, of Bear Ridge, near Kendrick, collected 125 at one time under a single band.

Inspector Hitt counted and destroyed 79 worms under a PAPER that had been wrapped round the trunk of an apple-tree to keep off jack-rabbits.

The highest record in our experiments was 110 worms on one tree, the band having been examined just one week before.

Without entering upon the details of results with different varieties, which did not show any striking variations, the total catch of worms for each period is given:

July	7	18	Trees	49	Worms
"	15	40	"	1701	"
"	21	40	"	1885	"
"	30	40	"	1231	"
Aug.	6	40	"	689	"
"	12	40	"	387	"
"	18	40	"	436	"
"	26	40	"	178	"
Sept.	4	40	"	74	"
"	10	40	"	143	"
"	17	(record lost)			
"	25	40	"	558	"
Oct.	1	40	"	448	"
"	8	40	"	311	"
"	15	40	"	180	"
		Total,		8270	(and 1 week omitted)

The record of Sept 17 was lost. It was intermediate between that of the preceding and following weeks, amounting to about 350. The grand total for the season was not less than 8,600 worms, or 215 per tree.

These trees had all been sprayed once except three. One was a young tree with only a few apples; the others were from ten to twelve years old, bearing moderately full on the average.

All the trees but one had two bands; this one had five bands, the object being to see if the worms coming down the trunk could not be kept separate from those which first dropped to the ground and then came up from below.

Even five bands were not enough to keep them separate, as the following figures show:

DATE	TOP B'D	2D B'D	3D B'D	4TH B'D	BOTTOM B'D	TOTAL
Jul. 7	2	0	1	1	0	4
" 15	27	4	4	4	3	42
" 21	32	9	5	11	7	64
" 30	11	12	12	11	18	64
Aug. 6	20	1	14	11	17	63
" 12	7	6	6	3	1	23
" 18	8	13	0	4	7	32
" 26	4	3	6	2	8	23
Sept. 4	4	1	2	1	4	12
" 10	6	3	3	2	3	17
" 17						
" 25	2	7	3	4	8	24
Oct. 1	0	8	13	7	9	37
" 8	20	9	11	8	7	55
" 15	13	4	6	6	5	34
	156	80	86	75	97	494

This was our highest record for worms on one tree, 494, with one week's record missing. The high number was not due to the number of bands, but to the fact that the tree was quite large and bore heavily.

The upper band caught about twice as many worms as either of the intermediate ones, and almost twice as many as the lower one. It is evident that the great majority of the worms crawl down the tree, although some other experiment will have to be devised to separate them entirely from those coming up.

If the majority of the worms crawl down the tree, then the majority of the wormy apples that fall have no worms in at the time. Consequently the advantage to be derived from having hogs in the orchard must be limited to a minority of the worms, and ought to be supplemented with other methods. Mr. Hupp, of Kendrick, believes, however, that hogs will not only eat the apples, but will search out the isolated worms in the earth under the trees. Mr. McPherson has suggested to me also that the proportion of windfalls containing the worm will depend greatly on the amount of wind during the time under consideration, since

this factor will make a difference of several days in the length of time that the wormy apple will hang. In the Juliaetta experiment, the tree was almost completely sheltered from the wind.

Of the 39 trees having two bands, the totals for upper and lower bands up to Oct. 1, omitting Sept. 17, were 3711 upper and 3517 lower. This does not of itself permit of any definite conclusion, but taken in connection with the five-banded tree, it emphasizes the fact that many worms crossed one band or more before settling down.

Figure 6 shows one of the trees in our experiments, with our method of banding. The overlapping end of the lower band has been turned back to show some cocoons of the moth.

SUMMARY.

1. One application of Paris green before the calyx closed destroyed 41 per cent of the worms of the first brood.

2. The spray was about six times as effective on worms entering the calyx as on those entering the side of the apple.

3. Of the first brood of worms, on unsprayed trees, only about 40 per cent entered the calyx.

4. Of later broods, the number entering the calyx was very small, almost none at all.

5. On 40 trees, an average of 215 worms per tree were collected under bands between July 1 and Oct. 15.

6. The number of worms that leave the apples before they fall, and crawl down the tree, is much larger than the number falling with the apple, or dropping to the ground with a thread, and afterward crawling up the tree. At least this is true in the absence of wind.

RECOMMENDATIONS.

Spray apple trees very thoroughly after the blossom falls, but before the calyx closes, with Paris green, one pound to 150 or 200 gallons of water, adding two pounds of fresh lime to a barrel of the spray to prevent damage to the foliage.

The subject of later sprayings has not been investigated at the Station, and no recommendations can be given this year. Authorities differ as to the value of spraying after the calyx has closed in the spring. At any rate, the benefit is less than from the first spraying. The best time for a second spraying would be two weeks after the first.

Band apple trees with soft cloth, drawn rather close. One moderately wide band should be used, probably two are better. Apply bands four weeks after the blossoms fall, and examine them once a week thereafter, except in the hotter arid parts of the state, where they should be examined every six days. Destroy all worms found under them, and replace the band as before.

As far as possible, collect the wormy apples from time to time during the summer, not waiting for the worms to leave them. Much good can be accomplished in this way.

Examine apple store-rooms in early spring for hibernating worms, and eradicate by fumigation or by screening the windows and catching them as they mature.

Pigs allowed to run in the orchard undoubtedly do much good. It would be well to shake the trees occasionally to bring down the windfalls before the worms have left.

The policy outlined here will result in average years in a saving of 80 to 90 per cent of the crop, if carried out with vigor and persistence. This has been demonstrated by a number of Idaho farmers.

NOTE:—Figs. 1, 2, and 3 come out somewhat too heavily shaded. The color of the insect is more grayish.