THE SPRING EMERGENCE OF THE CODLING MOTH*

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The codling moth passes the winter in the full-grown larval stage in a silken cocoon which it spins in the crotches and forks under the loose bark of the apple tree, as well as in other sheltered places about its base or on the ground near by. Early in the spring the larva changes to a brownish pupa from which in one to two weeks the adult moth emerges. When the atmospheric temperature at dusk is 60°F or above these moths begin to fly about and start oviposition. Under normal conditions these eggs will hatch in about 7 to 14 days. On hatching the young larva finds its way to the small apple and eats in through the side or calyx end. The date of emergence of the adult moth therefore becomes of the utmost importance to the apple grower who is depending on using arsenical sprays to protect his fruit. In order to control the codling moth most effectively by spraying, it naturally follows that, with the exception of the calyx spray, each spray application will be most effective if made just prior to the time the eggs start to hatch in larger numbers.

Observations on the earliest date of spring emergence of the adult moth have been made at Stillwater since 1924. It was found that over this period the earliest date at which the moths emerged was April 13. This early emergence was recorded in three of the twelve years for which records are available, namely 1925, 1928 and 1933. The latest date on which the first months began to emerge was April 28, 1930. This was the spring that followed a severe winter during which some of the lowest temperatures over the period were recorded. There appears to be no close correlation, however, between mean winter temperatures and date of first moth emergence. For example, during the winter of 1924-25 the average mean temperature were slightly lower than those recorded for the winter of 1929-30, yet the first months emerged on April 13, 1925, whereas the first emergence was not recorded until April 28, 1930. The average date of earliest moth emergence for th 12-year period is April 18, and this was the actual date of first emergence in the spring of 1927. The dates of earliest moth emergence for the twelve-year period are as follows; all dates are in April:

24, 1924	28, 1930
13, 1925	15, 1931
26, 1926	15, 1932
18, 1927	13, 1933
13, 1928	15, 1934
20, 1929	14, 1935

In the fall of 1934 it was decided to follow this spring emergence of the moths more closely and to its completion. Accordingly several hundred larvae were collected by the use of 2-in. strips of corrugated paper placed around the trunks of apple trees. The bands were collected in November and kept in small cages through the winter. They were then transferred to a large cage which was placed in an apple orchard under one of the trees, thus simulating natural conditions as nearly as possible. Beginning with April 1 the cages were observed daily at 5:00 p. m. in order to count and remove the moths that had emerged the previous 24-hour period. The daily temperatures were taken and recorded by means of a thermograph.

The first moth emerged in the cage on April 14 after which there was a lapse of eight days before the next moth emerged. Beginning with

*Carpocapsa pomonella Linn.

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April 25 the moths began to emerge in greater numbers, the number that emerged daily being closely associated with the daily atmospheric temperatures (Table I).

TABLE I. *Daily Emergence of Codling Moths of the Spring Brood and Daily Maximum Temperatures, Stillwater, Okla., Apr. 14 - June 20, 1935.*

Date	Max. temp. °F.	No. emerged	Date	Max. temp. °F.	No. emerged
Apr. 14	85	1	May 18	72	4
15	58	0	19	77	3
16	69	0	20	67	0
17	82	0	21	65	6
18	60	0	22	76	7
19	62	0	23	61	0
20	67	0	24	68	4
21	74	0	25	64	9
22	75	0	26	77	21
23	76	2	27	80	26
24	80	2	28	87	19
25	71	5	29	78	21
26	74	6	30	75	21
27	77	9	31	87	14
28	70	17	June 1	84	20
29	64	10	2	91	6
30	69	4	3	75	0
May 1	82	24	4	71	6
2	62	10	5	80	12
3	52	4	6	87	19
4	43	0	7	67	6
5	51	0	8	77	4
6	69	4	9	89	8
7	80	26	10	91	3
8	83	34	11	92	7
9	70	16	12	82	3
10	77	18	13	75	0
11	83	14	14	82	0
12	88	26	15	76	2
13	75	9	16	87	0
14	63	4	17	79	1
15	56	1	18	81	1
16	61	0	19	76	0
17	62	6	20	90	0

The period of emergence extended for slightly more than nine weeks, the first moths emerging on April 14 and the last on June 18. There were three distinct peaks of emergence which came on May 1, 8 and 27. The daily rate of emergence was rather closely associated with the atmospheric temperatures. Since no other records showing the complete period of emergence are available it is not possible to say definitely that this period is equally as long each spring. In 1924, however, several overwintered larvae had not pupated by May 19. Therefore it is possible that a long period of emergence in the spring may not be unusual.

The control of the codling moth has become more difficult in recent years and one of the causes is the long period of spring emergence of over-

wintered forms. Likewise might be included the fact that, at least in some seasons, the greatest number of moths do not emerge at one time to make what might be called a normal peak of emergence. With the moths emerging as they did in the spring of 1935 it would be possible for the adults of the first generation to appear before all of the moths from the overwintered forms had emerged. The result would be an overlapping of generations throughout the summer, which would necessitate the application of additional sprays. Then too, since successful control depends upon the proper timing of the spray applications to correspond with the hatching of the eggs, it would be easy to make the mistake of applying the arsenical to catch those larvae coming from the moths in the first peak only. If this is done it simply means that the damage to the apple crop will merely show up a few weeks later since this spraying would have little or no effect on the larvae coming from the second peak of emergence.

In the past the orchardist tried to get around this by making one spray application after another, and the more arsenic that adhered to the foliage and fruit the better he liked it. He went on the theory that the better and deeper the foliage and fruit were covered with the arsenical, the greater the chances of the young larvae coming in contact with it in their efforts to enter the fruit. The federal regulations regarding arsenic and lead tolerance on apples seriously interfere with this kind of procedure; in addition, they impose the problem of removing the arsenic and lead residue from the apples. Accordingly, in order to reduce the amount of spray residue, there now is a tendency for the orchardist to make a minimum number of spray applications. These are likely to be inefficient and untimely. These difficulties the orchardist can overcome in a large measure by obtaining the peak or peaks of spring emergence for the overwintering forms and timing the spray applications accordingly.