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LIFE HISTORY OF THE ORIENTAL PEACH MOTH AT RIVERTON, N. J., IN RELATION TO TEMPERATURE

By ALVAH PETERSON, *Senior Entomologist*, and G. J. HAEUSSLER, *Assistant Entomologist, Division of Deciduous Fruit Insects, Bureau of Entomology*

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INTRODUCTION

From 1925 to 1927, inclusive, a detailed life-history study was made of the oriental peach moth at Riverton, N. J. The species, *Laspeyresia molesta* Busck, belongs to the family Olethreutidae (Eucosmidae) and the order Lepidoptera. Particular attention was paid to the relationship occurring between temperature and the development of the insect.

In this bulletin, so far as possible and advisable, long detailed life-history tables have been omitted. Summary tables and graphs have been used in their place. Also all general information and biological data which do not have a direct bearing on the life cycle are omitted. Most of the information of this type which has been ascertained at Riverton, N. J., may be found in other publications by the writers (*9, 10, 11, 12*).[1]

EXPLANATION OF TERMS

The terms used in describing the various stages of the oriental peach moth for the most part are the same as those employed by workers of the Bureau of Entomology in life-history studies of the codling moth.

A "generation" begins with the egg and ends with the moth or adult. It may or may not be completed the same season the egg is deposited.

A "brood" consists of the individuals of any one stage in the life cycle, egg, larva, pupa, or adult; and it may be considered "first

[1] Italic numbers in parentheses refer to "Literature cited," p. 37.

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brood," "second brood," etc., depending upon the generation to which it belongs. "Spring brood" refers to pupae or adults which come from "wintering larvae."

"Wintering" refers to those individuals which hibernate, passing the winter as larvae in cocoons. Individuals of several generations (second to fifth or more) may be represented by the "wintering" individuals.

"Transforming" refers to those individuals which complete their life cycle the same season the eggs are deposited; thus we have "transforming eggs," "transforming larvae," "transforming cocoons," "transforming pupae" and "adults from transforming stages."

"Black spotted" refers to that stage in the development of the egg in which the dark head capsule of the larva usually shows through the eggshell 15 to 48 hours before the egg hatches.

The time during which the cocoon is being formed is called the "cocooning period," while the time from the beginning of formation of the cocoon until the adult emerges is called the "cocoon period."

The "life cycle" of any generation is the time from the deposition of the egg to the emergence of the adult, while the "complete life cycle" includes the time from the egg deposition of one generation to the egg deposition of the next generation.

The seasonal development in any year starts with "wintering larvae" inside of "wintering cocoons," which give rise to "spring-brood pupae," and from these "spring-brood moths" emerge. The "spring-brood moths" deposit the "first-brood eggs," and these in turn produce "first-brood larvae," "first-brood cocoons," "first-brood pupae," and "first-brood moths." The "first-brood moths" deposit the "second-brood eggs," and thus the story continues for several generations.

The "average temperature for a day" is the average of 12 readings in 24 hours (one reading every 2 hours from midnight to midnight) taken from a thermograph record.

The "theoretical zero of development" is the temperature at which development begins when the temperature is rising and at which it ceases when the temperature is falling.

The "degree of maximum rate of development" is the temperature at which development proceeds most rapidly.

The "day-degree" is the unit used for measuring accumulations of temperature and is equivalent to 1° of temperature maintained for 24 hours.

"Effective day-degrees" are day-degrees above the zero of development after necessary corrections have been made for retardation due to temperatures above the maximum rate of development. This correction is made by subtracting twice the day-degrees above the degree of maximum rate from the total of day-degrees above the zero of development.

METHODS AND EQUIPMENT

During the dormant season of 1924–25 the senior author started the life-history study discussed in this bulletin. For several years previous to 1925 he had the opportunity to observe the behavior of the insect in the orchards throughout New Jersey and also conducted a detailed life-history study at New Brunswick, N. J. The information derived from these experiences which has already been published

(*2, 3, 4, 5, 6, 7, 8, 13, 16*), proved to be very valuable because it helped to obviate mistakes and to improve the equipment for a careful study. One of the most serious mistakes eliminated was in conjunction with the spring-brood emergence of moths. In the life-history studies at New Brunswick the senior writer started with moths which emerged from material that had been kept all winter and spring in an open screened insectary, or in covered wooden boxes with screen bottoms. After the study was started it was learned that the moths had emerged about two weeks later than the first moths in the orchard; consequently the life-history study got a late start. This experience and considerable investigation since (*11*) has shown that great care must be taken with wintering material. It should be placed in a situation where the spring-brood emergence would be approximately the same as that in the orchard. Any decided deviation from the normal emergence in the orchard will influence considerably the development for the season. The matter of normal spring-brood emergence is most important if one expects to make a comparison between insectary development and orchard conditions.

Numerous wintering cocoons containing larvae were collected from peach and quince trees during the dormant season of 1924–25. These were brought to the laboratory and placed in screened cages out of doors, and some were placed in vials plugged with cotton in a screened insectary. The spring-brood moths used in the life-history study came from the material kept out of doors. When additional adults were needed some of the insectary material was used, provided the emergence was still taking place in the orchard and in the outdoor cages.

In this investigation a serious attempt was made to determine the extreme limits of time required and the average period of development for all of the individuals of each stage in each generation for the growing seasons of 1925 and 1926. No attempt was made to make the development of the insect in the insectary a duplicate of that in the orchard on a quantitative basis. The writers are of the opinion that this is almost impossible and also impractical, especially if one takes into consideration the tremendous and variable influence that parasites and other factors have on the severity of the infestation in the orchard.

One thousand individuals per generation reared to maturity was set as a standard for this investigation. This gave a sufficient number of individuals to use as a basis for any reasonable calculations. The mortality in rearing to maturity runs from 50 to 70 per cent. To rear 1,000 or more individuals of each generation to maturity it is necessary to start 100 eggs each day from each generation when possible. At the beginning and toward the end of the period for each brood of eggs and sometimes during cool weather an insufficient number were deposited to make use of 100 per day. One advantage in starting with a fixed number of individuals is that it furnishes a constant factor which is valuable in figuring mortality, daily averages of development, and many relationships between temperature and other environmental factors.

The insectary used in these studies measured 10 by 12 by 60 feet, was screened on all sides (except a central closed portion), and was covered with a hip roof. (Fig. 1.) It was located at the edge of a small peach orchard at Riverton, N. J.

The cages used for the wintering larvae kept out of doors were similar to those described in a previous publication (*11*) in which the authors discuss the best methods for determining the normal spring-brood emergence of oriental peach moths and codling moths. These cages were covered with screen and the cocoons were constantly exposed to the weather. The cages were fastened to poles, four near the ground and four about 5 feet above, with one of each set of four facing north, east, south, and west.

As the moths emerged in the spring of the year under outdoor conditions, 10 females and 10 males were selected each day and placed in a 6 by 8 inch glass jar containing 2 inches of moist sand, a wet sponge in a watch glass, and a sprig of fruit foliage (usually pear) in a small bottle. (Fig. 2.) The jar was covered with a good grade of white gauze held in place by two rubber bands. Each jar was placed on

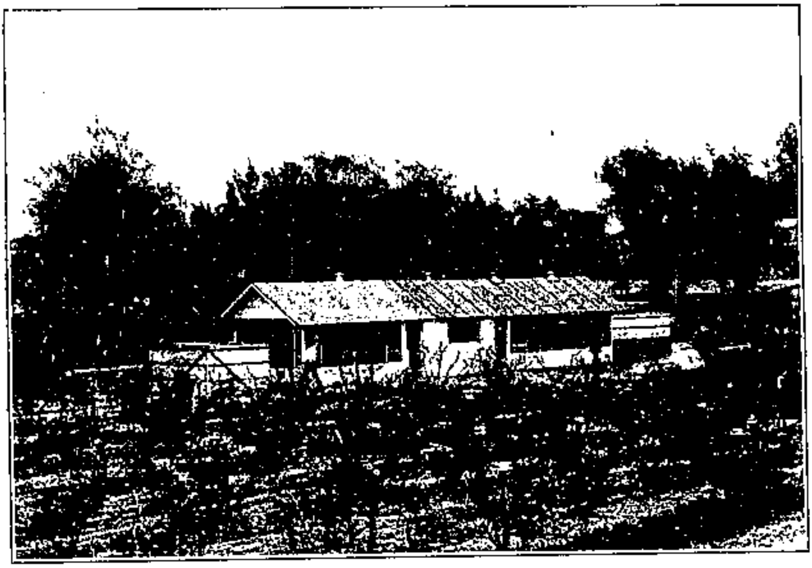

FIGURE 1.—Oriental peach-moth insectary, Riverton, N. J.

the west side of the insectary 5 feet above the ground and in such a a location that the late afternoon sun would strike it.

Early in the morning while it was cool the jars were examined for egg deposition and adult mortality. All the eggs were counted. If eggs were located on the glass they were marked or destroyed. If eggs were found on the leaves or stems the twig was removed and a new one was put in its place.

Moths were also placed in screen cages of various sizes and covered with gauze. Round cages, the same size as the jars, and oblong cages measuring 6 by 8 by 12 inches were used. The cages were kept in an insectary which had a screen roof and screen side walls so sunlight could strike them most of the day. The screen cages, particularly the oblong type (fig. 3), proved to be the most satisfactory from the standpoint of egg production; yet the adults lived no longer in these cages than in the glass jars.

The chief reason why moths produce more eggs in screen cages than in glass jars seems to be the greater circulation of air and the possibility of keeping them in sunlight without injuring the moths. Sunlight seems to be essential for maximum egg production. It was also found that codling moths produced a greater number of eggs in screen cages which were exposed to sunlight than in glass jars.


FIGURE 2.—Oriental peach-moth egg jar

All twigs bearing eggs were placed in the entirely screened portion of the insectary where the sunlight and rain could strike them. They were kept in this location until they were black-spotted. When the eggs were ready to hatch, 10 were placed on a green peach (or peaches, depending upon the size) in an 8-ounce jelly glass and covered with surgical gauze. All rearing in the life-history study in the insectary was carried on in peaches, except early in the

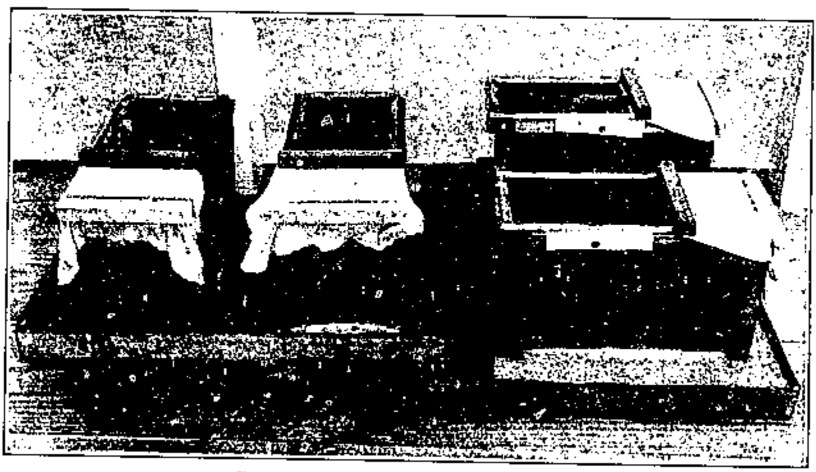
FIGURE 3.—Oriental peach-moth egg cages

season, when the fruit was not available or was too small and late in the season (September 20 or later), when peaches were no longer available. The first larvae of the first brood were reared on new, succulent peach twigs. Rearing larvae on twigs in the insectary is not very satisfactory, for the mortality is very high and a great deal of time is needed for rearing a few individuals. The last larvae of the late broods were reared in apples.

Each jelly glass was examined daily until the eggs hatched. When hatching occurred a record was made on each glass of the deposition, "black-spotted," and hatching dates. At this time each glass received a piece of corrugated strawboard (one-half by 3 inches long, with four corrugations to the inch), and was covered with a piece of strong, finely woven gauze which was held in place by two one-eighth by 2 inch rubber bands. (Fig. 4.)

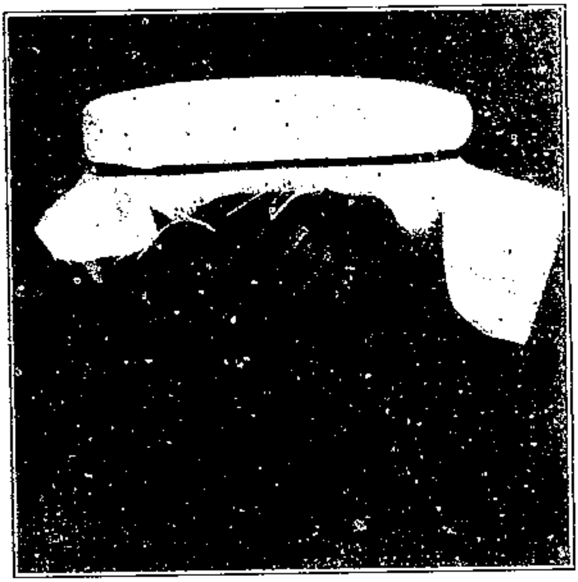

FIGURE 4. Jelly glass used for rearing oriental peach-moth larvae

The glasses were placed in trays, and the trays were placed in racks in the center of the screened insectary. When full-grown larvae made their appearance the glasses were examined daily. The majority of the larvae entered the corrugated paper strips and spun cocoons. These cocoons were removed once a day.

At the time the cocoons were removed from the glasses a record was made on 5 by 8 inch cards of all the information pertaining to each individual. All the life-history records and all sorts of notes were kept on 5 by 8 inch cards. (Fig. 5.)

Each cocoon was given a number which was written on the smooth part of the corrugated board or on a separate piece of paper. The individual cocoons were placed in 3-dram homeopathic vials plugged with cloth-covered cotton plugs. These vials were placed in small racks (fig. 6), which in turn were placed in trays and kept in the center of the screened portion of the insectary. The cocoons in the vials were examined daily for adult emergence. When an adult emerged its number and sex were recorded. No pupation records were made from the cocoons placed in homeopathic vials.

For pupation records 5 to 10 full-grown larvae were placed each day individually in 2-dram shell vials (fig. 7) stoppered with cloth-covered cotton plugs. These larvae spun their cocoons against the glass, usually adjacent to the plug, consequently it was an easy matter to note the changes in each larva through the glass.

Life History—Brood III—1926. ⑦

No.	Dep. date	Incubation period		B.S. date	H. date	Feeding period		Coc. date	Cocoon period		Adult emergence date		Life cycle period		Misc. notes
		♀	♂			♀	♂		♀	♂	♀	♂	♀	♂	
2109	7/8	4		7/11	7/12	12		7/24	13		8/6		29		
2110			4				12			12		8/5		28	
1	7/9	4		7/12	7/13	11			13		8/6		28		
2	7/10		5	7/14	7/15		9			13		8/6		27	
3	7/7	4		7/10	7/11	14		7/25	12		8/6		30		
4			4				14			13		8/7		31	
5		4				14			13		8/7		31		
6		4				14			12		8/6		30		
7			4				14			12		8/6		30	
8	7/8		4	7/11	7/12		13			13		8/7		30	
9			4				13			13		8/7		30	
~~2120~~															dead
1		4 4				13 13			12 13		8/6 8/7		29 30		Duplicate
2			4				13			12		8/6		29	
3	7/9		4	7/12	7/13		12			13		8/7		29	
4			4				12			13		8/7		29	
5			4				12			13		8/7		29	
6		4				12			13		8/7		29		

FIGURE 5.—Sample record of oriental peach-moth life history

A thermograph and maximum and minimum thermometers were kept adjacent to the feeding larvae and cocoons within the insectary. Normal air circulation was available about the temperature-recording instruments, and no direct rays of sunlight came in contact with the

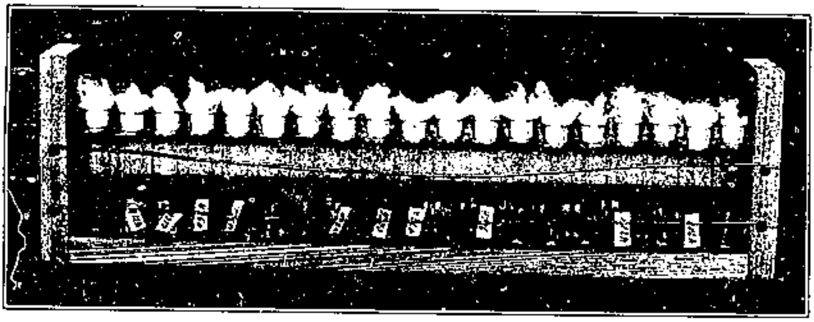

FIGURE 6.—Rack of homeopathic vials containing oriental peach-moth cocoons used for obtaining records of adult emergence in the insectary

bulbs. The thermometers and thermograph were read daily from May 1, 1925, to August 1, 1927. The temperature records were also checked against those obtained at the Japanese beetle laboratory and the near-by Weather Bureau stations.

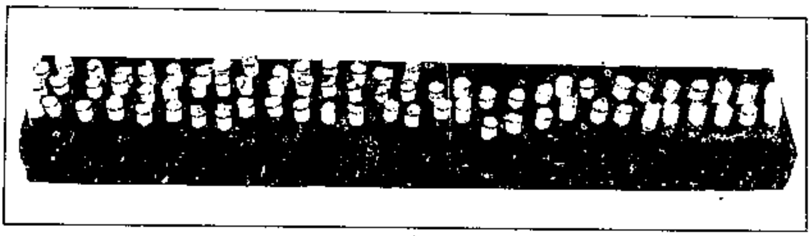

FIGURE 7.—Oriental peach-moth cocoons in shell vials used for pupation records

INSECTARY AND ORCHARD COMPARED

In conducting a life-history study of an insect in an insectary one can not expect to duplicate the life history of the insect in the field in all details. All one can hope to do is to provide closely approximate conditions and then carefully check the results with those found in the natural environment.

In this life-history study all the stages were checked with those under orchard conditions as carefully as possible. In checking the insectary results with the development in the orchard several methods were used, and various observations were made. The spring-brood emergence was checked by noting the date of appearance of the first moths in the orchard. This was determined by the presence of moths or of fresh empty pupal skins on the south side of fruit trees. For three years the first emergence in the orchard has occurred on the same day or within 24 hours of the time the first adults appeared in the outdoor screen cages facing south adjacent to the ground.

Bait pans were used to determine the peak of abundance of the spring-brood moths in the orchard, which agreed closely with the peak of emergence in the screened outdoor cages. Bait-pan catches are also useful in determining the emergence of the first-brood moths in the orchard. After the middle of July bait-pan records are extremely irregular; consequently they can not be used as a check on the development of the insect within the insectary.

The incubation period in the insectary throughout the season was checked against orchard conditions by placing 50 or more eggs daily in a peach orchard the morning after they were deposited. The small bottles containing the peach or pear foliage which had eggs on them were placed on wooden stands in the center of 7 to 8 year old peach trees. Almost every day the incubation period of the eggs placed out of doors was exactly the same as that of those eggs kept in the open screened insectary. In a few instances in cool weather or during decided changes in the weather there was a difference of 12 to 24 hours one way or the other. However, this difference is no greater than that which occurs in the orchard itself, because eggs exposed to direct sunlight sometimes hatch 12 to 24 hours sooner than those which are shaded.

The senior author in 1924 reared a goodly number of larvae in the orchard in twigs and fruit and at the same time reared larvae in picked green peaches in the insectary. In most every test the period of development of the outdoor larvae was the same as that of those reared in the insectary. In a few of the tests the larvae reared out of doors in growing green tissue required one or two days longer for development. Under insectary conditions throughout the season there is a distinct difference in the period of development of larvae in green peaches and in green apples. They develop more slowly in apples than in peaches. If a given lot of larvae require 12 days to develop in peaches, a similar lot may require 15 days in apples.

Since conditions would not permit the carrying on of a large-scale life-history study under strictly orchard conditions, it was necessary to rear the larvae in picked fruit in the insectary. During both seasons peaches were used as long as they were available (from late in May to late in September).

The development of the larvae in twigs in young orchards was checked with the development of larvae in the insectary, and for the most part they agreed closely. By collecting larvae from several young (2 to 4 year old) peach orchards regularly once a week for a given number of minutes the peak of larval abundance was ascertained, and the size of the larvae gave a good check on the development of the early generations in the orchard. This was particularly true of the first and second generations.

The cocoon period under insectary conditions was checked against that under the outdoor conditions by placing in the orchard daily, so far as possible, small screen cages containing 5 to 10 newly formed cocoons in corrugated paper. These small cages (wire strainers mounted on pieces of board) were placed on all parts of peach trees or on the ground below the trees. The cocoon period of the transforming cocoons placed out of doors checked closely with similar lots of individuals kept in vials in the insectary. This, however, was not true of wintering material kept in the insectary, as mentioned before and fully discussed in an earlier publication (*11*).

LIFE HISTORY OF THE ORIENTAL PEACH MOTH

GENERAL DISCUSSION

In presenting the detailed information on the life history the writers do not intend to follow the usual method which many authors have used in presenting life-history data on the oriental peach moth or similar insects, such as the codling moth. Much of the detailed tabular information will be omitted; however, the more important information pertaining to dates for each stage and sex in each generation and the period of time required for the development of each stage and sex in each generation will be found in the summary tables. The average period for "all broods" in each case was obtained by dividing the total number of days by the total number of individuals. Some of the information in these tables will not be considered in the discussion. The summary tables will serve as a good reference for anyone interested in a life-history study of the oriental peach moth, especially in an area where the climate is similar to that in southern New Jersey. The summary tables on the life history include only those individuals which completed all stages of their development; consequently for any generation the number of individuals for all the stages is the same. The number of individuals reared in each generation is shown in Table 1. This table also shows the number and percentage of transforming and wintering individuals in each brood for the two years.

The life-history discussion will consider the more important biological facts for each stage in the life of the insect and the relationship to temperature. The influence of effective day-degrees for each stage is discussed under a separate heading.

The charts and tables giving information on the relationship of development to effective day-degrees include data on all of the individuals which completed any given stage under consideration.

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TABLE 1.—*Number of individuals per brood used in the life-history studies of the oriental peach moth in 1925 and 1926 at Riverton, N. J., and the percentage of transforming and wintering individuals in each brood*

Brood	Transforming individuals			Wintering individuals			Total individuals			Proportion of individuals transforming			Proportion of individuals wintering		
	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both
1925	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
First	582	668	1,250	0	0	0	582	668	1,250	100	100	100	0	0	0
Second	760	735	1,495	1	0	1	761	735	1,496	99.9	100	99.9	0.1	0	0.1
Third	393	410	803	285	229	514	678	639	1,317	58.0	64.2	61.0	42.0	35.8	39.0
Fourth	26	41	67	209	208	417	235	249	484	11.1	16.5	13.8	88.9	83.5	86.2
Fifth	0	0	0	21	14	35	21	14	35	0	0	0	100	100	100
Total or av.	1,761	1,854	3,615	516	451	967	2,277	2,305	4,582	77.3	80.4	78.9	22.7	19.6	21.1
1926															
First	488	438	926	0	0	0	488	438	926	100	100	100	0	0	0
Second	528	463	991	0	0	0	528	463	991	100	100	100	0	0	0
Third	185	172	357	561	508	1,069	746	680	1,426	24.8	25.3	25	75.2	74.7	75
Fourth	0	0	0	242	234	476	242	234	476	0	0	0	100	100	100
Total or av.	1,201	1,073	2,274	803	742	1,545	2,004	1,815	3,819	59.9	59.1	59.5	40.1	40.9	40.5

THE EGG

The egg (fig. 8) is scalelike in form, round or oval, flattened toward the edge, the upper surface minutely rugose; the color is grayish white, somewhat iridescent; and the average measurement across is about 0.7 millimeter.

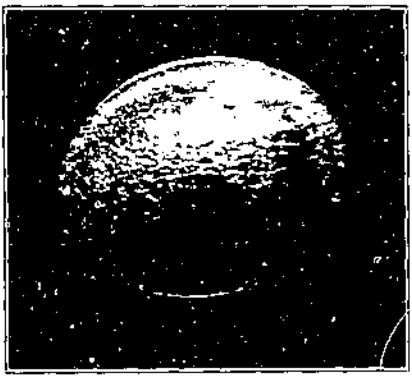

FIGURE 8.—Egg of oriental peach moth. × 50

In peach orchards most of the eggs are found on the under surface of two-thirds to full-grown leaves, near the terminal ends of growing twigs. This is particularly true in the case of young trees. In quince and apple orchards the eggs are placed on the smooth upper surface of the leaves, while in pear orchards eggs may be deposited on the upper and lower leaf surfaces. Eggs are also deposited on newly formed smooth twigs, such as those of peach and pear. The texture of the surface on which eggs are deposited seems to be important. Smooth surfaces are preferred to rough or pubescent ones. When adults are placed inside of smooth glass jars (6 by 8 inches) containing foliage of peach, pear, or apple, most of the eggs will be deposited on the smooth glass rather than on the leaves. When adults are placed in small screen cages made entirely of screen and cloth and containing twigs from fruit trees, the eggs are deposited mainly on the twigs and not on the cages. If smooth wooden supports are used in the construction of the cages, many eggs will be deposited on the wood. This may be prevented by frequently coating the wooden supports with concentrated lime-sulphur.

A few hours previous to hatching, the newly formed larva can be seen inside the eggshell. Its dark head is the first visible portion and shows as a dark spot near the center of the egg. An egg in this stage is called "black-spotted." When summer temperatures prevail, the black spot appears 15 to 48 hours before the egg hatches. In case the incubation period is three and one-half days, the black spot appears 15 to 18 hours before the larva emerges.

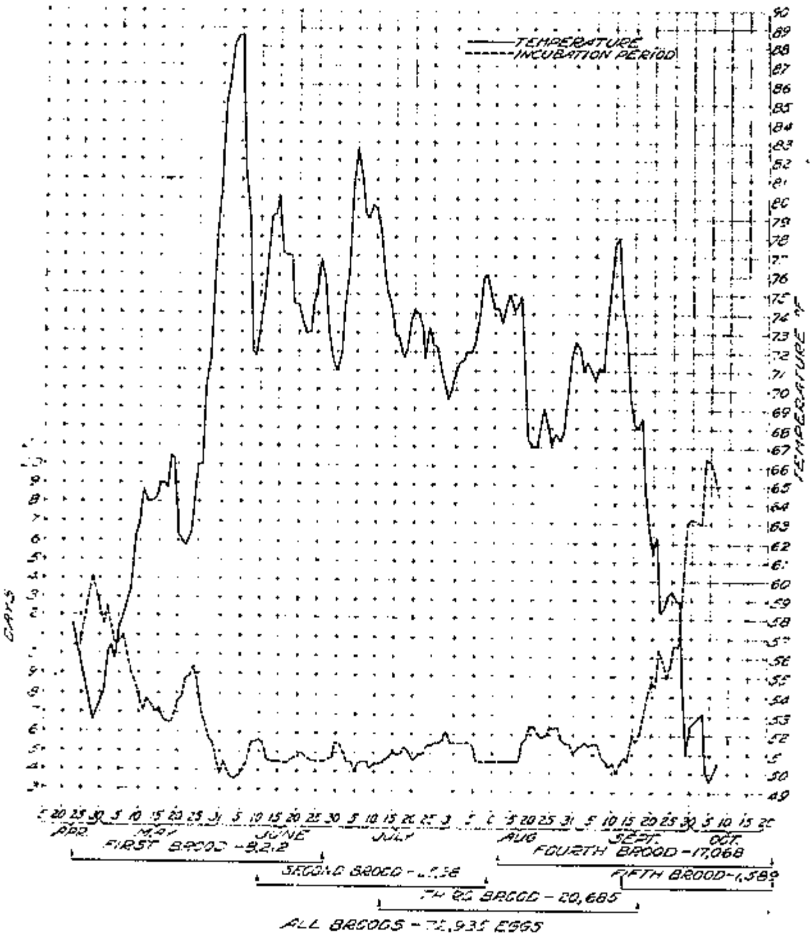

FIGURE 9.—Average incubation periods of eggs of the oriental peach moth compared with the average temperatures for the respective incubation periods, at Riverton, N. J., season of 1925

When the larva has completed its development within the eggshell, it bites its way out and emerges through the slitlike opening. The mortality in normal fertilized eggs which are not parasitized is very low, being about 2 to 5 per cent.

The incubation period of the egg is largely dependent upon temperature. Figures 9 and 10 and Tables 2 and 3 show the decided variations in this period. In the summer, when warm weather is more or less continuous, the eggs hatch in the insectary and out of doors in 3½ to 6 days, whereas early in the spring the first eggs deposited by the adults of the spring brood require 7 to 14 or more days to hatch. Late in the fall (October and November), when cool weather is almost continuous, the incubation period may be 20 days or longer. Under constant temperature conditions in the laboratory, averaging 86° to 88° F., all eggs hatch in three days or less. The minimum time for the incubation period under constant and controlled temperature has been 60 to 65 hours.

The incubation-period curve for the seasons shown corresponds fairly well (inversely, of course) with the ups and downs in the temperature curve. It is probable that a closer agreement between the

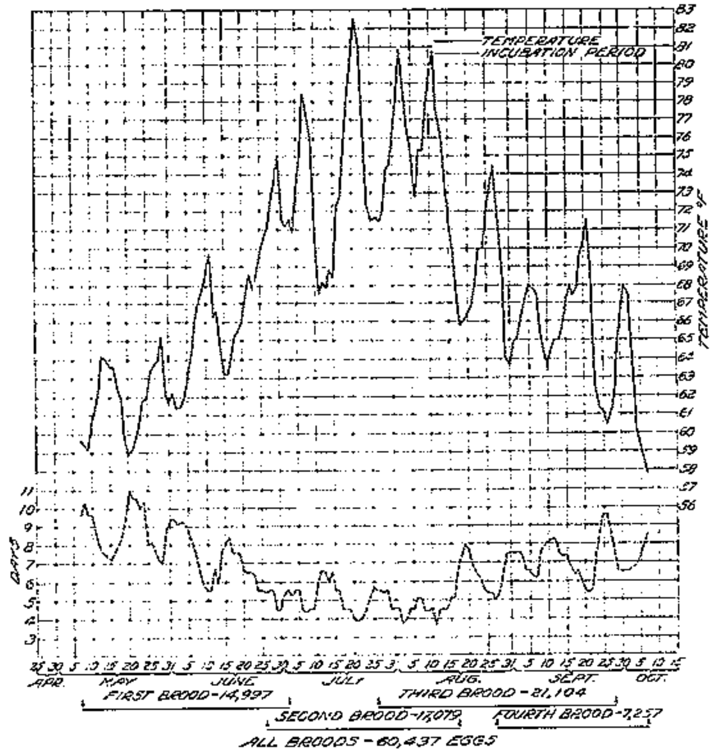

FIGURE 10.—Average incubation periods of eggs of the oriental peach moth compared with the average temperatures for the respective incubation periods, at Riverton, N. J., season of 1925

details of these curves would have resulted if the observations on the incubation period of the eggs had been made oftener than once a day. Each point in the incubation curve indicates the average period of time required for all eggs deposited on a given day. Each point on the temperature curve opposite a deposition date is the average temperature during the average incubation period (days and fraction) following the deposition date. For example, the average incubation period of eggs deposited on June 30, 1925, was five days, and the temperature recorded on the temperature curve is 71° F., which is the average of all temperatures recorded for five days from June 30 to July 4, inclusive.

TABLE 2.—*Incubation periods and deposition dates of oriental peach-moth eggs at Riverton, N. J., 1925*

Brood	Incubation periods: Average, Male	Average, Female	Average, Both	Maximum, Male	Maximum, Female	Minimum, Male	Minimum, Female	Deposition dates: First, Male	First, Female	Last, Male	Last, Female
	Days	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*				
TRANSFORMING INDIVIDUALS											
First	5.59	5.49	5.54	9	9	3	3	Apr. 23	Apr. 25	June 24	June 24
Second	4.49	4.48	4.48	6	6	3	3	June 10	June 10	Aug. 6	Aug. 6
Third	4.91	4.85	4.88	6	6	4	4	July 12	July 12	Aug. 31	Aug. 31
Fourth	4.62	4.90	4.79	6	6	4	4	Aug. 14	Aug. 13	Aug. 26	Aug. 28
All broods	4.89	4.87	4.88	9	9	3	3	Apr. 23	Apr. 25	Aug. 31	Aug. 31
WINTERING INDIVIDUALS											
Second	5.00	----	5.00	5	------	5	------	Aug. 2	------	Aug. 2	------
Third	4.86	4.91	4.89	6	6	4	4	July 31	Aug. 1	Sept. 13	Sept. 14
Fourth	5.12	5.16	5.14	7	[1] 11	4	4	Aug. 13	Aug. 14	Sept. 18	Sept. 26
Fifth	5.68	6.71	6.08	8	[1] 17	5	5	Sept. 13	Sept. 13	Sept. 20	Sept. 29
All broods	5.00	5.08	5.01	8	17	4	4	July 31	Aug. 1	Sept. 20	Sept. 29
BOTH TRANSFORMING AND WINTERING INDIVIDUALS											
First	5.59	5.49	5.54	9	9	3	3	Apr. 23	Apr. 25	June 24	June 24
Second	4.49	4.48	4.48	6	6	3	[illegible]	June 10	June 10	Aug. 6	Aug. 6
Third	4.89	4.87	4.88	6	6	4	[illegible]	July 12	July 12	Sept. 13	Sept. 14
Fourth	5.06	5.12	5.09	7	11	4	[illegible]	Aug. 13	Aug. 13	Sept. 18	Sept. 26
Fifth	5.66	6.71	6.08	8	17	5	5	Sept. 13	Sept. 13	Sept. 20	Sept. 29
All broods	4.92	4.92	4.92	9	17	3	3	Apr. 23	Apr. 25	Sept. 20	Sept. 29

[1] 1 individual.

TABLE 3.—*Incubation periods and deposition dates of oriental peach-moth eggs at Riverton, N. J., 1926*

Brood	Incubation periods: Average, Male	Average, Female	Average, Both	Maximum, Male	Maximum, Female	Minimum, Male	Minimum, Female	Deposition dates: First, Male	First, Female	Last, Male	Last, Female
	Days	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*				
TRANSFORMING INDIVIDUALS											
First	6.95	6.79	6.88	[1] 14	11	4	5	May 13	May 13	June 26	June 26
Second	4.33	4.43	4.38	6	6	3	3	June 26	June 26	Aug. 8	Aug. 11
Third	4.23	4.28	4.25	6	7	3	3	July 26	July 26	Aug. 17	Aug. 19
All broods	5.38	5.37	5.38	14	11	3	3	May 13	May 13	Aug. 17	Aug. 19
WINTERING INDIVIDUALS											
Third	5.95	6.14	6.04	8	8	3	3	Aug. 3	Aug. 7	Sept. 25	Sept. 24
Fourth	6.78	6.83	6.80	9	9	5	4	Aug. 27	Aug. 27	Sept. 24	Sept. 23
All broods	6.20	6.35	6.27	9	9	3	3	Aug. 3	Aug. 7	Sept. 25	Sept. 24
BOTH TRANSFORMING AND WINTERING INDIVIDUALS											
First	6.95	6.79	6.88	14	11	4	5	May 13	May 13	June 26	June 26
Second	4.33	4.43	4.38	6	6	3	3	June 26	June 26	Aug. 9	Aug. 11
Third	5.52	5.66	5.59	8	8	3	3	July 26	July 26	Sept. 25	Sept. 24
Fourth	6.78	6.83	6.80	9	9	5	4	Aug. 27	Aug. 27	Sept. 24	Sept. 23
All broods	5.71	5.77	5.74	14	11	3	3	May 13	May 13	Sept. 25	Sept. 24

[1] 1 individual.

THE LARVA

Oriental peach-moth larvae range in length from 1.5 to approximately 12 millimeters. (Fig. 11.) In all larval instars the larvae possess biting mouth parts, three pairs of true jointed legs, located on the thoracic segments, and five pairs of fleshy false legs (prolegs), located on the ventral aspects of the third, fourth, fifth, sixth, and last abdominal segments. The larva in its development casts its skin four or five times; consequently there are four or five larval instars. The number of instars is dependent upon the rate of growth of the larva. With slow growth there are five instars, and with rapid growth, four instars. The rapidity of growth is dependent upon at least two factors—temperature and type of food. More detailed information on the number of larval instars is given in an earlier publication (*12*). Larvae in all larval instars except the last are white, with a black head and dark-colored thoracic and anal shields; in the last instar the larva is at first a dirty white or gray, but as it increases in size it gradually becomes pink or almost red. It has been noted that mature larvae which have fed on peach tissue are more likely to be red (or pink) than larvae which have fed on apples or quinces. The head and the thoracic and anal shields in the last instar are brown (mottled). A small, brown, chitinized anal fork is present on the ventral aspect of the last abdominal segment caudad of the anal opening, and is most prominent in the last larval instar.

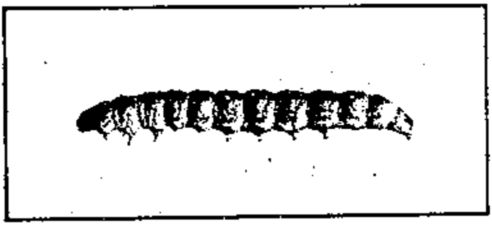

FIGURE 11.—Oriental peach-moth larva, lateral view. × 3

A newly hatched larva immediately seeks food. Even though small, it is active and can crawl a considerable distance in a short time. It proceeds to enter the first desirable plant tissue found. When suitable plant food is located, the larva spins a loose silken covering about itself, which probably gives it some support while gouging out pieces of the plant tissue. The first mouthfuls of tissue are set to one side unconsumed. The larva begins to feed when its head is deeply embedded in the plant tissue.

Larvae transforming during the summer require 6 to 24 days to complete their growth, the average time being approximately 12 days. Late in the season, when cool weather is almost continuous, larvae (wintering) may require as many as 50 to 115 days. In New Jersey all wintering larvae pass the winter in cocoons so far as known. The rate of larval development and its relationship to temperature is illustrated in Figures 12 and 13. Each point on the feeding-period curve is the average time required for all larvae hatching on that date to complete their development irrespective of the generation they may represent, while each point on the temperature curve is the average of all temperatures the larvae of a given date were subjected to during their average feeding period. For example, 11 days was the average feeding period for all larvae hatching on June 4, 1925, and the average temperature recorded for that day was 79° F. This temperature was obtained by averaging all of the temperatures for 11 days, beginning with and following the hatching date.

Wintering larvae may sometimes be found in the second generation and are present in all succeeding generations at Riverton, N. J. In 1925 all of the first-brood larvae completed their development during the current season, one individual of the second brood was

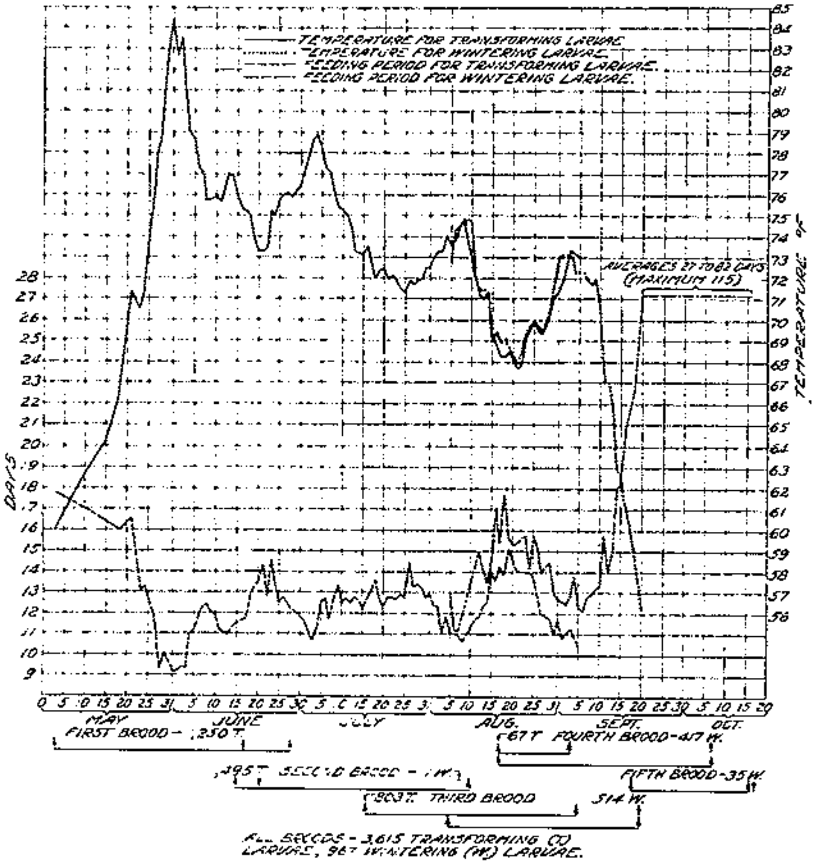

FIGURE 12.—Average feeding periods of transforming and wintering larvae of the oriental peach moth compared with the average temperatures for the respective feeding periods, at Riverton, N. J., season of 1925

a wintering larva, and the succeeding generations (third, fourth, and fifth) produced successively greater percentages of wintering larvae. (Table 4.) In 1926 all of the first and second brood larvae transformed, while 75 per cent of the third and all of the fourth generation were wintering larvae. (Table 5.)

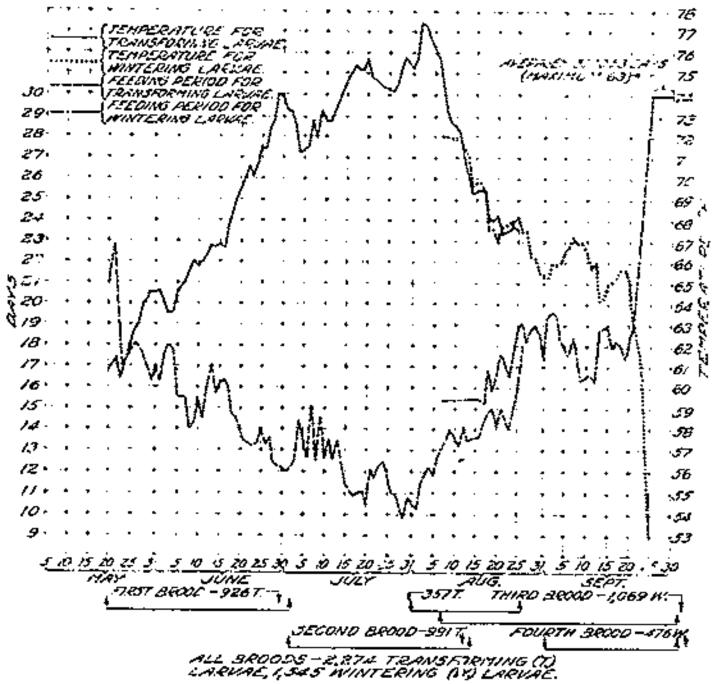

FIGURE 13.—Average feeding periods of transforming and wintering larvae of the oriental peach moth compared with the average temperatures for the respective feeding periods, at Riverton, N. J., season of 1926

TABLE 4.—*Feeding periods and hatching dates of oriental peach-moth larvae at Riverton, N. J., 1925*

TRANSFORMING INDIVIDUALS

Brood	Feeding periods							Hatching dates			
	Average			Maximum		Minimum		First		Last	
	Male	Female	Both	Male	Female	Male	Female	Male	Female	Male	Female
	Days	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*				
First	10.61	11.15	10.80	18	[1] 24	6	7	May 3	May 5	June 28	June 28
Second	12.07	12.92	12.40	19	21	8	8	June 15	June 15	Aug. 10	Aug. 10
Third	12.11	12.73	12.42	22	20	8	8	July 16	July 16	Sept. 5	Sept. 5
Fourth	13.31	13.85	13.64	16	21	8	10	Aug. 18	Aug. 17	Sept. 1	Sept. 3
All broods	11.70	12.38	12.05	22	24	6	7	May 3	May 5	Sept. 5	Sept. 5

WINTERING INDIVIDUALS

Brood	Avg. Male	Avg. Female	Avg. Both	Max. Male	Max. Female	Min. Male	Min. Female	First Male	First Female	Last Male	Last Female
Second	11.00	...	11.00	11	...	11	...	Aug. 7		Aug. 7	......
Third	14.05	14.72	14.35	21	23	8	8	Aug. 5	Aug. 6	Sept. 18	Sept. 20
Fourth	16.19	15.86	16.02	91	85	9	9	Aug. 17	Aug. 18	Sept. 25	Oct. 7
Fifth	41.09	41.14	41.11	115	82	13	10	Sept. 18	Sept. 18	Sept. 28	Oct. 16
All broods	16.01	16.06	16.04	115	85	8	8	Aug. 5	Aug. 6	Sept. 28	Oct. 16

BOTH TRANSFORMING AND WINTERING INDIVIDUALS

Brood	Avg. Male	Avg. Female	Avg. Both	Max. Male	Max. Female	Min. Male	Min. Female	First Male	First Female	Last Male	Last Female
First	10.61	11.15	10.80	18	24	6	7	May 3	May 5	June 28	June 28
Second	12.07	12.92	12.40	19	21	8	8	June 15	June 15	Aug. 10	Aug. 10
Third	12.93	13.44	13.18	22	23	8	8	July 16	July 16	Sept. 18	Sept. 20
Fourth	15.87	15.53	15.69	91	85	8	9	Aug. 17	Aug. 17	Sept. 25	Oct. 7
Fifth	41.09	41.14	41.11	115	82	13	10	Sept. 18	Sept. 18	Sept. 28	Oct. 19 /16
All broods	12.75	13.16	12.95	115	85	6	7	May 3	May 5	Sept. 28	Oct. 16

[1] 1 individual.

Table 5.—*Feeding periods and hatching dates of oriental peach-moth larvae at Riverton, N. J., 1926*

Brood	Feeding periods							Hatching dates			
	Average			Maximum		Minimum		First		Last	
	Male	Female	Both	Male	Female	Male	Female	Male	Female	Male	Female
TRANSFORMING INDIVIDUALS											
	Days	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*				
First	14.21	14.72	14.45	25	24	10	10	May 20	May 20	July 1	July 1
Second	11.54	12.44	11.96	21	19	8	8	July 1	July 1	Aug. 12	Aug. 14
Third	12.44	13.66	13.03	21	21	8	10	July 31	July 31	Aug. 23	Aug. 26
All broods	12.70	13.57	13.14	25	24	8	8	May 20	May 20	Aug. 23	Aug. 26
WINTERING INDIVIDUALS											
Third	18.87	19.11	18.99	62	63	11	11	Aug. 7	Aug. 12	Oct. 2	Oct. 2
Fourth	22.56	21.80	22.19	61	58	14	14	Sept. 1	Sept. 1	Oct. 2	Sept. 30
All broods	19.98	19.96	19.97	62	63	11	11	Aug. 7	Aug. 12	Oct. 2	Oct. 2
BOTH TRANSFORMING AND WINTERING INDIVIDUALS											
First	14.21	14.72	14.45	25	24	10	10	May 20	May 20	July 1	July 1
Second	11.54	12.44	11.96	21	19	8	8	July 1	July 1	Aug. 12	Aug. 14
Third	17.27	17.73	17.49	62	63	8	10	July 31	July 31	Oct. 2	Oct. 2
Fourth	22.56	21.80	22.19	61	58	14	14	Sept. 1	Sept. 1	Oct. 2	Sept. 30
All broods	15.65	16.18	15.90	62	63	8	8	May 20	May 20	Oct. 2	Oct. 2

Wintering larvae have a slightly longer feeding period than transforming larvae. This is illustrated in Figures 12 and 13, where the curves showing the number of days required for the development of larvae which started their development at the same time overlap. The curve for wintering larvae in all cases is above that for the transforming larvae. If one takes into consideration the number of larvae existing in the period when both transforming and wintering larvae are developing, it will be noted that the feeding period of wintering larvae is approximately one or more days longer than that of transforming larvae.

THE COCOON

The cocoon (fig. 14) is a silken covering spun by a full-grown larva for its protection during hibernation and while it changes to and exists as a pupa. After a larva completes its development in a twig or fruit it usually eats its way out, drops to the ground by means of a silken thread, or crawls down the tree, and seeks a place suitable for spinning a cocoon. Larvae which drop to the ground, or come out of fallen fruit, spin their cocoons on, under, or within some object on the ground, whereas larvae which crawl down the tree may spin their cocoons on some part of the tree. The cocoon averages one-half inch in length and three-sixteenths inch in width and is made of silken threads and particles of the objects on which it rests; these particles may be bark, peach pubescence, sand, leaves, or other material. Usually a cocoon is constructed in 24 to 48 hours.

In the summer the cocoons are more fragile than are those of the wintering forms. The summer cocoons may be found on fruit, in axils of twigs, under pieces of bark, and in other situations. The more substantial wintering cocoons are found in rough places on the tree, particularly in the crotches and under rough bark on the trunk. If late varieties of peaches have been heavily infested, cocoons may occur in considerable numbers on the trunks of the trees near the ground. Old quince trees with shaggy bark afford excellent hibernation quarters; frequently a dozen or more cocoons of the oriental peach moth may be bunched together under one piece of quince bark. Cocoons may also be found under flakes of apple-tree bark, when an infestation has occurred in the apples.

Cocoons are also found in places other than on the host plant. Trash of all kinds underneath infested trees serves as hibernation

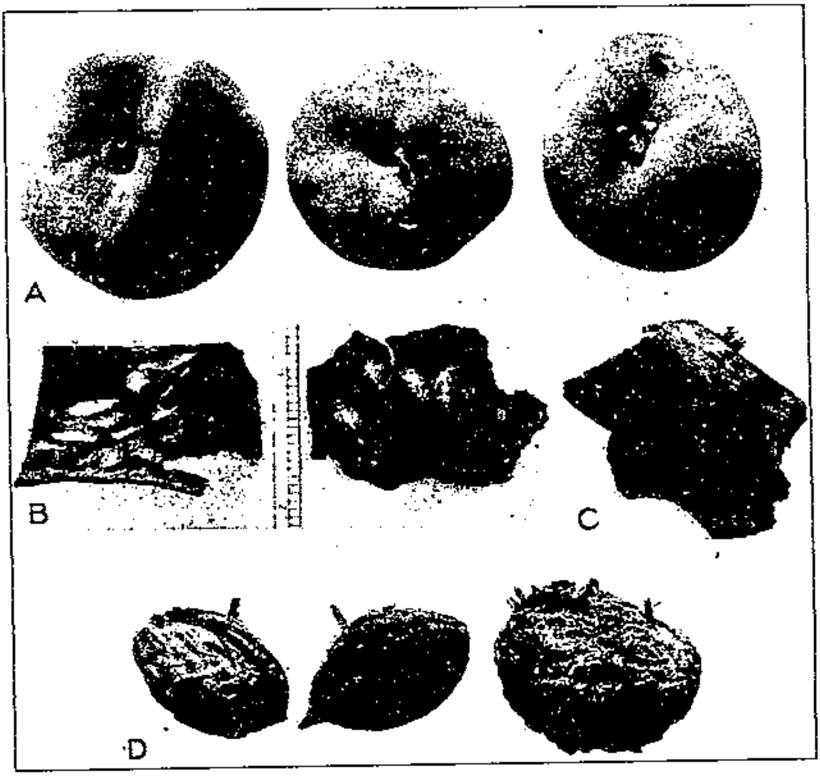

FIGURE 14.—Oriental peach-moth cocoons and hibernation quarters: A, summer cocoons on peaches; B, wintering cocoons under quince bark; C, D, empty pupal skins protruding from typical hibernation quarters. Two-thirds natural size

quarters. Cocoons have been found on old dried peaches and quinces. After heavy infestation of quince trees some of the larvae spin cocoons inside of the fruit, near the skin. Old dried quinces in the spring sometimes have six or more protruding empty pupal shells after all the adults of the spring brood have emerged.

The cocoon period (Tables 6 and 7) for transforming individuals was 8 to 33 days, or an average of approximately 14 days for the two seasons. The wintering-cocoon period ranged from 131 to 307 days for the two winter periods. The relationship between the temperatures existing during the summer period and the length of the cocoon period is illustrated in Figures 15 and 16. The high points of the temperature curve correspond for the most part with the low points of the time curve. The location of a given point on the cocoon-period curve indicates the average time required for all of the insects within the cocoons formed on a given date to complete their development. The temperature indicated for any day is the average of all

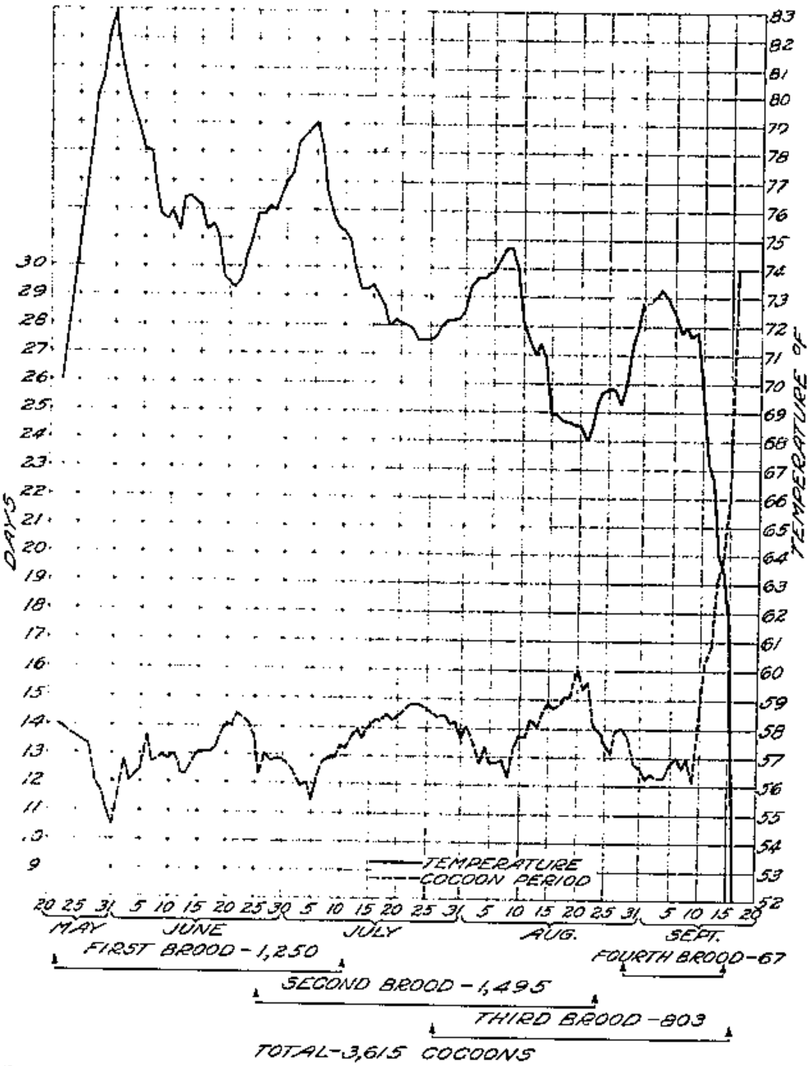

FIGURE 15.—Average cocoon periods of transforming individuals of the oriental peach moth compared with the average temperatures for the respective cocoon periods, at Riverton, N. J., season of 1925

temperatures the cocoons formed on a given date were subjected to during their average cocoon period. For example, the average cocoon period for all cocoons formed on July 15, 1925, was 14 days, and the average temperature recorded for that day is 73.3° F. This temperature is the average temperature for 14 days following and including July 15.

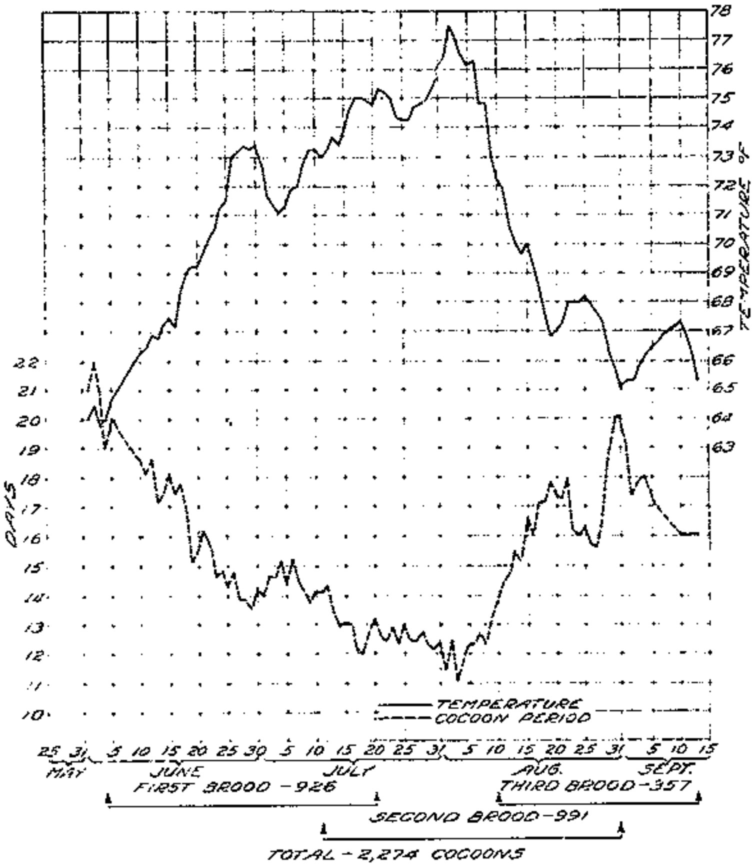

FIGURE 16.—Average cocoon periods of transforming individuals of the oriental peach moth compared with the average temperatures for the respective cocoon periods, at Riverton, N. J., season of 1926

TABLE 6.—*Cocoon periods and cocooning dates of oriental peach-moth cocoons at Riverton, N. J., 1925*

TRANSFORMING INDIVIDUALS

Brood	Cocoon periods (prepupal and pupal)							Cocooning dates			
	Average			Maximum		Minimum		First		Last	
	Male	Female	Both	Male	Female	Male	Female	Male	Female	Male	Female
	Days	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*				
First	13.17	12.93	13.04	20	18	10	9	May 24	May 22	July 11	July 10
Second	14.05	13.62	13.77	19	24	8	9	June 26	June 26	Aug. 23	Aug. 24
Third	14.41	14.00	14.22	33	20	10	10	July 27	July 27	Sept. 16	Sept. 15
Fourth	13.23	14.32	13.90	17	20	10	10	Aug. 31	Aug. 29	Sept. 12	Sept. 15
All broods	13.84	13.53	13.68	33	20	8	9	May 24	May 22	Sept. 16	Sept. 15

WINTERING INDIVIDUALS

Brood	Average Male	Average Female	Average Both	Maximum Male	Maximum Female	Minimum Male	Minimum Female	First Male	First Female	Last Male	Last Female
Second	287.00	......	287.00	287	......	287	......	Aug. 18	....	Aug. 18	....
Third	262.04	262.68	262.32	298	306	225	232	Aug. 17	Aug. 17	Oct. 7	Oct. 7
Fourth	258.05	259.35	258.70	302	299	153	156	Sept. 2	Sept. 3	Dec. 22	Dec. 15
Fifth	210.14	200.78	205.80	253	251	131	150	Oct. 1	Oct. 4	Jan. 14	Jan. 2
All broods	258.30	259.40	258.85	302	306	131	150	Aug. 17	Aug. 17	Jan. 14	Jan. 2

TABLE 7.—*Cocoon periods and cocooning dates of oriental peach-moth cocoons at Riverton, N. J., 1926*

TRANSFORMING INDIVIDUALS

Brood	Cocoon periods (prepupal and pupal)							Cocooning dates			
	Average			Maximum		Minimum		First		Last	
	Male	Female	Both	Male	Female	Male	Female	Male	Female	Male	Female
	Days	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*				
First	14.94	14.53	14.75	25	25	9	11	June 4	June 10	July 15	July 20
Second	13.59	13.52	13.56	26	31	9	9	July 11	July 13	Aug. 20	Aug. 31
Third	16.95	16.47	16.72	33	26	9	11	Aug. 10	Aug. 11	Sept. 6	Sept. 13
All broods	14.66	14.41	14.54	33	31	9	9	June 4	June 10	Sept. 6	Sept. 13

WINTERING INDIVIDUALS

Brood	Male	Female	Both	Male	Female	Male	Female	Male	Female	Male	Female
Third	254.54	258.07	256.74	304	307	178	176	Aug. 25	Aug. 29	Nov. 27	Nov. 30
Fourth	239.08	245.94	242.43	284	288	178	178	Sept. 10	Sept. 17	Nov. 27	Nov. 27
All broods	250.01	255.00	252.40	304	307	178	176	Aug. 25	Aug. 29	Nov. 27	Nov. 30

THE PUPA

After the cocoon is completed, the larva becomes quiescent, and gradually its body shortens and becomes thicker. The duration of this prepupal stage averages three or four days during the summer (Table 8), after which the larva sheds its skin, and a yellowish pupa (fig. 17), about one-fourth of an inch in length, emerges. If a larva, after constructing a cocoon late in August and during September, does not change to a pupa within five to seven days, more than likely it will live over the winter unchanged. Almost without exception all pupae formed late in the season emerge as adults during the current season. So far as known no oriental peach moth survives the winter in the pupal stage. After a pupa is formed, it gradually turns reddish and becomes darker. From 24 to 48 or more hours before the adult emerges the wing cases of the pupa turn black, and a few hours prior to emergence the entire pupa becomes dark in color. At length the pupa pushes its way through the loosely spun end of the cocoon and the adult breaks the pupal shell near the cephalic end along the meson.

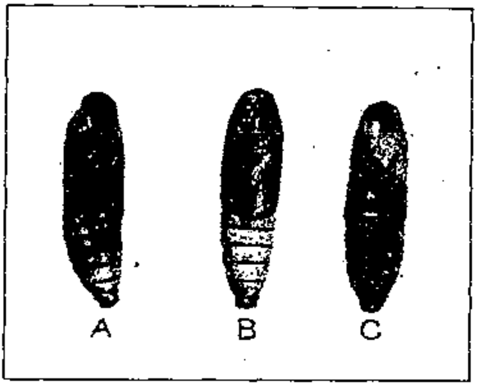

FIGURE 17.—Oriental peach-moth pupa: A, lateral view; B, ventral view; C, dorsal view. × 4

The length of the pupal stage is shown for 1926 in Table 8. For transforming individuals the minimum period is 7 days, the maximum 13 days, and the average for the season is 9.81 days. For wintering individuals which change to pupae early in the spring the average pupal stage is 27.35 days, and the minimum and maximum periods are 17 and 51 days, respectively. In the material reared for observation of the pupal stage it will be noted, from the dates shown for the various periods, that there is not the distinct overlapping of broods that occurs in the life-history study of the other stages. This is due to the fact that only a small proportion of the life-history material was allowed to spin up in shell vials for observation of the pupal transformations, and owing to the scarcity of cocooning individuals at the beginning and end of each brood none was taken for this purpose at that time. The records for the pupal stage in 1925 are incomplete, consequently they are omitted, yet the partial records obtained agree closely with those for 1926.

TABLE 8.—*Prepupal and pupal periods and cocooning and pupation dates of oriental peach moths which formed cocoons in 1926 at Riverton, N. J.*

Brood	Prepupal period (from cocooning to pupation)							Pupal period (from pupation to emergence)						
	Average			Maximum		Minimum		Average			Maximum		Minimum	
	Male	Female	Both	Male	Female	Male	Female	Male	Female	Both	Male	Female	Male	Female
	Days	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*
First [1]	4.03	4.31	4.16	7	8	1	1	9.99	9.61	9.82	12	11	7	7
Second [1]	3.42	3.22	3.32	7	8	1	1	9.22	9.32	9.28	13	13	7	7
Third [1]	4.35	4.00	4.12	6	9	2	1	11.87	11.46	11.60	13	13	11	10
First, second, and third [1]	3.77	3.74	3.75	6	9	1	1	9.82	9.79	9.81	13	13	7	7
Third [2]	218.81	223.71	220.05	246	255	172	159	28.30	26.25	27.35	51	51	22	17

Brood	Cocooning dates				Pupation dates			
	First		Last		First		Last	
	Male	Female	Male	Female	Male	Female	Male	Female
First [1]	June 18	June 19	July 15	July 15	June 22	June 24	July 20	July 20
Second [1]	July 15	July 15	Aug. 19	Aug. 20	July 19	July 19	Aug. 24	Aug. 24
Third [1]	Aug. 10	Aug. 19	Sept. 3	Sept. 13	Aug. 21	Aug. 21	Sept. 9	Sept. 15
First, second, and third [1]	June 18	June 19	Sept. 3	Sept. 13	June 22	June 24	Sept. 9	Sept. 15
Third [2]	Aug. 31	Aug. 31	Oct. 12	Oct. 12	1927 Mar. 18	1927 Mar. 19	1927 May 20	1927 June 3

[1] Transforming individuals. [2] Wintering individuals; moths emerging in spring of 1927.

THE ADULT

The adult, the last stage in the life cycle of the insect, is a small grayish-brown (fuscous) moth (fig. 18) with a wing span of approximately one-half inch. The following description by A. Busck (*14*) agrees with the writers' observations.

Laspeyresia molesta, n. sp.

Head dark, smoky fuscous; face a shade darker, nearly black; labial palpi a shade lighter fuscous; antennae simple, rather stout, half as long as the forewings, dark fuscous with thin, indistinct, whitish annulations. Thorax blackish fuscous; patagia faintly irrorated with white, each scale being slightly white-tipped. Forewings normal in form; termen with slight sinuation below apex; dark fuscous, obscurely irrorated by white-tipped scales; costal edge blackish, strigulated with obscure, geminate, white dashes, four very faint pairs on basal half and three more distinct on outer half besides two single white dashes before apex; from the black costal intervals run very obscure, wavy, dark lines across the wing, all with a strong outwardly directed wave on the middle of the wing; on the middle of the dorsal edge the spaces between three of these lines are more strongly irrorated with white than is the rest of the wing, so as to constitute two faint and poorly defined, white dorsal streaks. All these markings are only discernible in perfect specimens and under a lens; ocellus strongly irrorated with white, edged

FIGURE 18.—Adults of the oriental peach moth, dorsal view: A, With wings spread; B, natural position when at rest. × 7

by two broad, perpendicular, faint bluish metallic lines and containing several small, deep black, irregular dashes, of which the fourth from tornus is the longest and placed farther outward, so as to break the outer metallic edge of ocellus; the line of black dashes as well as the adjoining bluish metallic lines are continued faintly above the ocellus in a curve to the last geminate costal spots; there is an indistinct, black apical spot and two or three small black dots below it; a thin but distinct, deep black, terminal line before the cilia; cilia dark bronzy fuscous. Hind wings dark brown with costal edge broadly white; cilia whitish; underside of wings lighter fuscous with strong iridescent sheen; abdomen dark fuscous with silvery white underside; legs dark fuscous with inner sides silvery; tarsi blackish with narrow, yellowish white annulations.

Alar expanse: 10 to 15 mm.

United States National Museum type 20664.

Males and females resemble each other closely. The female is usually a trifle larger; this difference is especially noticeable in the abdomen of the female when filled with eggs. The abdomen of a female is somewhat swollen, and a circular depression or area surrounded by a ring of scales occurs at the posterior end of the ventral side. The abdomen of a male is narrow, pointed at the end, and bears a slitlike mark at the posterior end on the ventral aspect.

Adults are most active about sundown. They have an irregular, up and down, or zigzag, flight. In the orchard they may be seen darting about the terminals, or new growth, of their host plants. Adults are occasionally very active in the middle of the day; this seems to be particularly true of the spring brood. When confined in 6 by 8 inch glass jars with moist sand and water, moths were found to live 3 to 37 days. (Table 9.) The average length of life of adults is 14 or 15 days during the summer, but in the spring and fall they may live much longer.

TABLE 9.—*Length of life of adults of the oriental peach moth at Riverton, N. J., 1925 and 1926*

Year	Brood	Moths			Length of life						
					Average			Maximum		Minimum	
		Male	Female	Both	Male	Female	Both	Male	Female	Male	Female
		No.	*No.*	*No.*	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*
1925	First	250	240	490	15.12	14.34	14.71	23	22	3	4
	Second	355	346	701	14.53	14.41	14.47	26	29	4	4
	Third	256	219	475	15.62	15.72	15.67	32	36	5	6
	Fourth	28	38	66	20.32	20.37	20.35	30	32	10	12
	Fifth	889	843	1,732	15.10	15.09	15.10	32	36	3	4
1926	Spring	321	318	639	16.96	17.88	17.42	30	37	3	5
	First	259	256	515	14.44	13.86	14.15	37	25	3	3
	Second	326	307	633	15.70	15.48	15.59	32	28	5	5
	Third	61	55	116	16.49	16.47	16.48	27	25	7	5
	Fifth	967	936	1,903	15.83	15.91	15.87	37	37	3	3
1925 and 1926 combined.	Spring	321	318	639	16.96	17.88	17.42	30	37	3	5
	First	509	496	1,005	14.77	14.09	14.43	37	25	3	3
	Second	681	653	1,334	15.09	14.90	15.00	32	29	4	4
	Third	317	274	591	15.78	15.87	15.82	32	36	5	5
	Fourth	28	38	66	20.32	20.37	20.35	30	32	10	12
	Fifth	1,856	1,779	3,635	15.52	15.48	15.50	37	37	3	3

Egg deposition usually begins 2 to 5 days after the females emerge and continues for 7 to 10 days, or even longer. Unless the female is fertilized, few or no eggs will be deposited. The maximum number of eggs are deposited when the females are exposed to sunlight a goodly portion of the day and have access to plain or sweetened water.

Females deposit 100 to 200 or more eggs. In one series of trials 10 females were placed in each of 10 different glass jars, 6 by 8 inches in size, with 5 to 10 males in each jar. The egg production per female ranged from 96 to 227, and averaged 148 for the entire lot. Possibly under natural conditions more eggs per female might have been deposited by these same moths.

Most eggs are deposited late in the afternoon, and deposition continues until an hour after sunset. On warm cloudy days the eggs may be deposited earlier in the day. Also some eggs may be deposited just before sunrise, if the temperature is near 70° F. or higher. Practically no eggs are deposited when the temperature during the normal egg-deposition period is below 60°. The most favorable temperatures seem to be between 70° and 90°.

Temperature has considerable influence on the time of day adults emerge. Early in the season or during periods when the nights are cool (50° F. or below) and when the morning hours are cool the peak of daily emergence occurs at noon or shortly thereafter, whereas on days when the night and early morning temperatures are fairly high the adults come out earlier, and the peak of emergence occurs about 9 a. m. A sudden cold spell of two or three days during the period of rapid emergence will check the daily emergence very decidedly for a day or two.

The location of the cocoon, particularly the wintering cocoon, influences the time of emergence of the adult. If the cocoon is exposed to direct sunlight for a number of hours per day the chances are that the adult will emerge much sooner than if the cocoon is located in a completely shaded situation. Light rays may have some influence on the time of emergence. It is known that the direct rays of the sun make a very great difference in the temperature of the environment where a cocoon is located. This is particularly true of wintering cocoons and is illustrated and discussed by the writers in a previous publication (*11*). The first spring-brood moths emerge in the orchard about the time the first peach blossoms appear and the leaves are beginning to form.

THE LIFE CYCLE

The life cycle (Tables 10 and 11) of transforming individuals for the two seasons ranges from 23 to 59 days, with seasonal averages of 30 and 33 days for the two seasons. Generally speaking, an individual moth completes its development in one month during most of the growing season. The life cycle for wintering individuals ranged from 232 to 331 days, with averages of 278 and 279 days for the two winters.

TABLE 10.—*Life-cycle periods and dates of adult emergence of oriental peach moths from eggs deposited in 1925 at Riverton, N. J.*

TRANSFORMING INDIVIDUALS

Brood	Life-cycle periods: Average, Male	Average, Female	Average, Both	Maximum, Male	Maximum, Female	Minimum, Male	Minimum, Female	Dates of moth emergence: First, Male	First, Female	Last, Male	Last, Female
	Days	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	1925	1925	1925	1925
First	29.38	29.56	29.47	47	40	23	24	June 5	June 5	July 25	July 25
Second	30.50	31.03	30.76	40	42	25	25	July 8	July 8	Sept. 7	Sept. 7
Third	31.46	31.57	31.52	50	42	25	26	Aug. 10	Aug. 9	Oct. 16	Oct. 5
Fourth	31.15	33.07	32.33	35	46	26	27	Sept. 11	Sept. 11	Sept. 28	Oct. 12
All broods	30.44	30.78	30.61	50	46	23	24	June 5	June 5	Oct. 16	Oct. 12

WINTERING INDIVIDUALS

Brood	Life-cycle periods: Average, Male	Average, Female	Average, Both	Maximum, Male	Maximum, Female	Minimum, Male	Minimum, Female	Dates of moth emergence: First, Male	First, Female	Last, Male	Last, Female
								1926	1926	1926	1926
Second	303.00	......	303.00	303	......	303	......	June 1	......	June 1	......
Third	281.01	282.17	281.53	317	328	217	252	May 15	May 16	June 29	July 9
Fourth	270.59	280.36	270.87	325	318	244	241	May 19	May 20	July 5	July 6
Fifth	256.00	254.64	256.00	271	268	244	246	May 22	May 19	June 11	June 12
All broods	270.42	280.48	270.91	325	328	244	241	May 15	May 16	July 5	July 9

TABLE 11.—*Life-cycle periods and dates of adult emergence of oriental peach moths from eggs deposited in 1926 at Riverton, N. J.*

TRANSFORMING INDIVIDUALS

Brood	Life-cycle periods							Dates of moth emergence			
	Average			Maximum		Minimum		First		Last	
	Male	Female	Both	Male	Female	Male	Female	Male	Female	Male	Female
	Days	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	1926	1926	1926	1926
First	36.12	36.05	30.08	50	51	20	29	June 23	June 28	Aug. 1	Aug. 3
Second	29.44	30.40	29.80	44	48	24	25	July 24	July 25	Sept. 17	Sept. 18
Third	33.62	34.41	34.00	53	47	26	28	Aug. 23	Aug. 24	Oct. 6	Sept. 26
All broods	32.80	33.35	33.05	53	51	24	25	June 23	June 28	Oct. 6	Sept. 26

WINTERING INDIVIDUALS

Brood	Male	Female	Both	Male	Female	Male	Female	Male	Female	Male	Female
								1927	1927	1927	1927
Third	279.57	284.42	281.87	324	331	232	243	May 11	May 11	July 17	July 21
Fourth	268.41	274.55	271.43	308	310	243	242	May 13	May 23	July 3	July 11
All broods	276.20	281.30	278.05	324	331	232	242	May 11	May 11	July 17	July 21

TABLE 12.—*First and last dates of spring-brood emergence of oriental peach moths in 1925, 1926, and 1927, at Riverton, N. J.*

Type of inclosure	Year	Dates of moth emergence			
		First		Last	
		Male	Female	Male	Female
Screened insectary and outdoor cages	1925	Apr. 13	Apr. 13	June 19	June 14
Screened insectary	1926	May 15	May 16	July 5	July 9
Outdoor screen cages	1926	May 4	May 4	June 13	June 22
Screened insectary	1927	May 11	May 11	July 17	July 21
Outdoor screen cages	1927	Apr. 7	Apr. 11	June 11	July 2

The relationship between prevailing temperatures and the length of the life cycle of transforming individuals is illustrated in Figures 19 and 20. The location of a given point on the time curve indicates the average time required for the individuals from eggs deposited on the given day to complete their life cycle. The temperature indicated for any day is the average of all temperatures the individuals starting on that day were subjected to for the period of their average life cycle. For example, the average life cycle for all the individuals from eggs deposited on June 24, 1925, was 30 days, and the temperature recorded for that day was 75.4. This temperature is the average of all temperatures for 30 successive days starting with June 24.

GENERATIONS PER SEASON

At Riverton, N. J., in 1925 there were five complete or partial generations and in 1926 four complete or partial generations, as shown in Figure 21. This chart also shows the beginning dates and the 25, 50, 75, and 100 per cent completion dates of moth emergence, egg deposition, hatching, and cocoon formation for each generation in 1925 and 1926.

TEMPERATURE AND EFFECTIVE DAY-DEGREES

The chief reason why there was such a decided difference in the number of generations and the dates when the various stages in the several generations occurred in 1925 and 1926 was the marked difference in temperature during the two seasons. Table 13 and Figure 22 show the decided contrast. In Table 13 it will be noted that June, July, and September were warmer in 1925 than in 1926. This was particularly true of June and September. From May 1 to September 30 the monthly mean temperatures for 1926 averaged 3.3° lower than for 1925, the total of the effective day-degrees (50 to

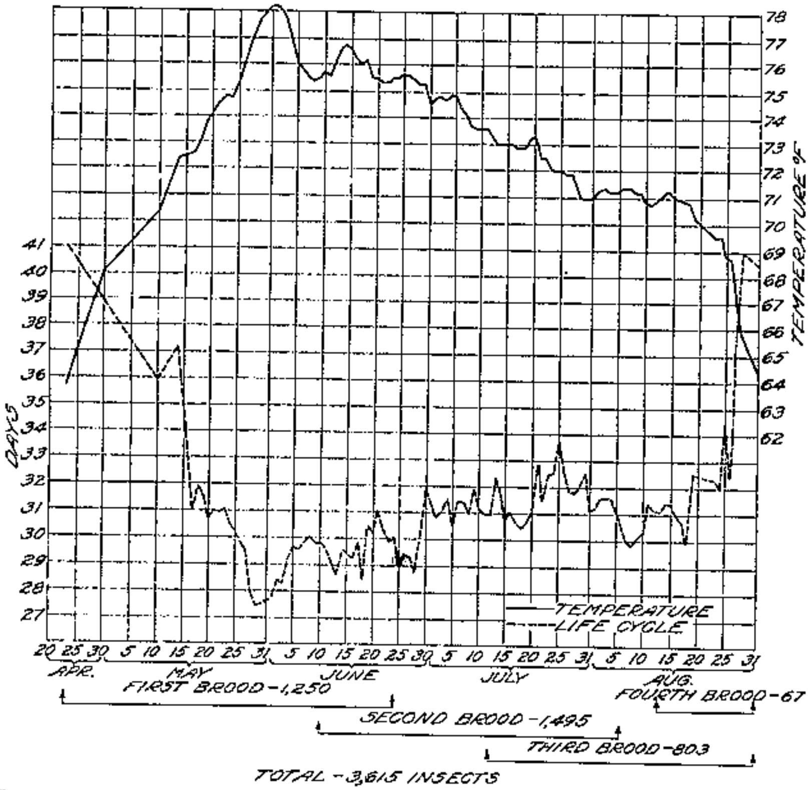

FIGURE 10.—Average life cycle, egg to adult, of transforming individuals of the oriental peach moth compared with the average temperatures for the respective life-cycle periods, at Riverton, N. J., season of 1925

86° F.) for this period in 1926 was 333.3 less than in 1925, and the monthly average was 66.6 effective day-degrees less than in 1925. In 1925 there were 66 days between May 1 and September 30 when the temperature exceeded 86°, while in 1926 there were only 19 days when the temperature exceeded 86°. The monthly mean temperatures were taken from the Weather Bureau records and from temperatures recorded by investigators at the Japanese beetle laboratory. The accumulated effective day-degrees (50° to 86°) in the insectary were figured from 12 readings taken from thermograph records for each 24-hour period. In Figure 22 each point on the curves indicates the average number of day-degrees above 50° for seven days. These are ascertained by adding the day-degrees for the three previous days and the three following days to those of the given date and dividing by seven.

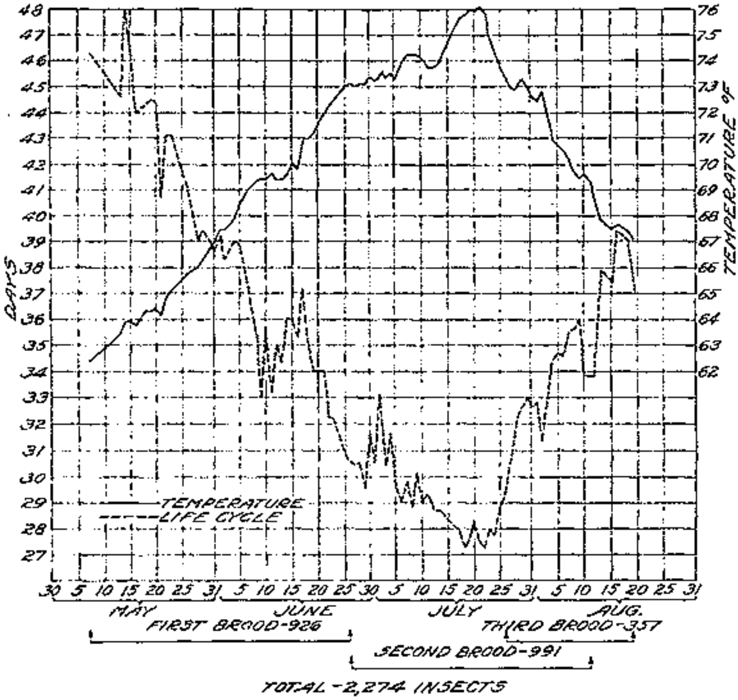

FIGURE 20.—Average life cycle, egg to adult, of transforming individuals of the oriental peach moth compared with the average temperatures for the respective life-cycle periods, at Riverton, N. J., season of 1926

TABLE 13.—*Comparisons of temperature for 1925 and 1926, at Riverton, N. J.*

Month	Mean temperatures			Effective day-degrees		
	1925	1926	More (+) or less (−) in 1926	1925	1926	More (+) or less (−) in 1926
	° F.	*° F.*	*° F.*			
May	59.1	59.7	+0.6	358.4	346.7	−11.7
June	76.4	65.2	−11.2	722.1	473.9	−248.2
July	73.6	72.6	−1.0	720.4	692.4	−28.0
August	72.1	73.0	+0.9	653.8	606.8	+43.0
September	70.4	64.6	−5.8	538.3	449.9	−88.4
Total	351.6	335.1	−16.5	2,993.0	2,659.7	−333.3
Average	70.3	67.0	−3.3	598.6	531.9	−66.6

In the detailed life-history study of the oriental peach moth no serious attempt was made to control temperature and other factors. However, careful observations were made on the development of the insect under insectary conditions (see "Methods and equipment," p. 2), and continuous records were kept of the daily temperatures by thermographs and maximum and minimum thermometers. Most of the information presented bearing on temperature is based on these observations.

In 1922 Glenn (*1*) published a paper on the relationship existing between effective day-degrees and the development of the codling moth. Glenn's paper has been subjected to considerable criticism, yet it showed the decided importance of temperature as a factor in the development of the codling moth. It also showed for the first time that in general the effective degrees for the development of the

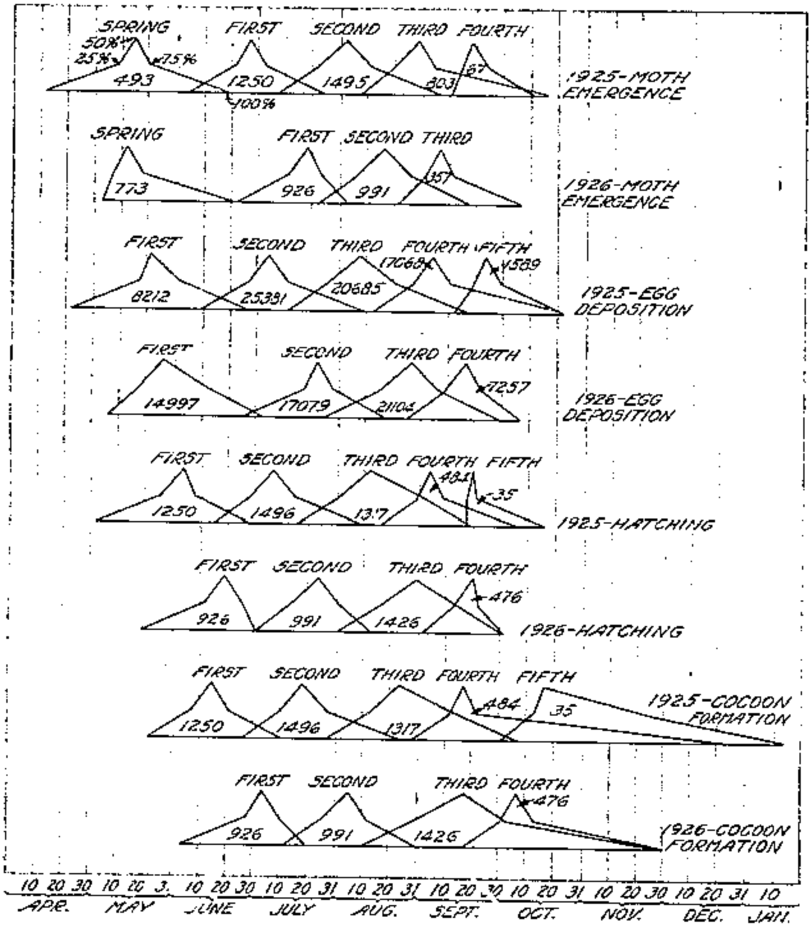

FIGURE 21.—Summarized life-history chart of the oriental peach moth for 1925 and 1926, at Riverton, N. J. The triangular figures show the beginning dates and the 25, 50, 75, and 100 per cent completion dates of adult emergence, egg deposition, larval hatching, and cocoon formation for the several generations in each season

codling moth were between 50° and 86° F.; the 50° being the theoretical zero of development and the 86° being the degree of maximum rate of development, and every additional degree above 86° retarded development at the same rate as every advancing degree below 86° accelerated development. In other words, to ascertain the number of effective day-degrees needed for the development of any stage of an individual only those degrees between 50° and 86° are favorable, and corrections should be made for all temperatures above 86°.

In these studies extensive and intensive use has been made of Glenn's ideas and theories, and the results have proved to be most interesting. Table 14 summarizes the results obtained when the idea of effective day-degrees was applied to large numbers of individuals of each stage for two seasons. When it is considered that the two seasons of 1925 and 1926 were extremely different from the standpoint of temperature, it is rather significant that the average total of effective day-degrees for the two seasons should so closely approximate each other for all stages. This fact alone indicates strongly that the 50° to 86° range is approximately correct for the oriental peach moth and further emphasizes the close relationship existing between the codling moth and the oriental peach moth.

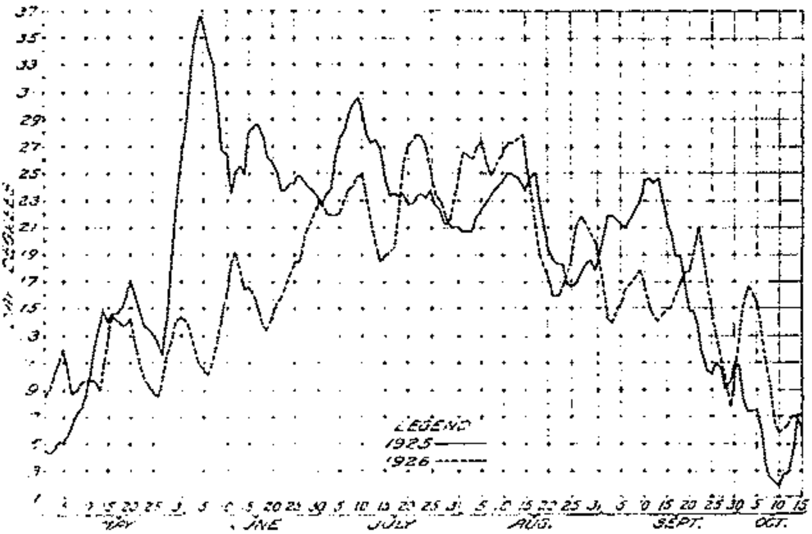

FIGURE 22.—Comparison of 7-day averages of the day-degrees above 50° F., from May 1 to October 15, for 1925 and 1926, in the insectary at Riverton, N. J.

TABLE 14.—*Average number of effective day-degrees (50° to 86° F.) needed to complete the development of the several stages of the oriental peach moth in 1925 and 1926 in an open screen insectary at Riverton, N. J.*

Stage	Item	Period	Number of individuals 1925	Number of individuals 1926	Number of effective day-degrees 1925	Number of effective day-degrees 1926	More (+) or less (—) in 1926
Egg	A	Unobserved half day of incubation period.	40,210	23,507	10.4	8.7	—1.7
	B	Observed part of incubation period	40,210	23,507	99.6	102.1	+2.5
	C	Entire incubation period	40,210	23,507	110.0	110.8	+0.8
Larva	D	Feeding period of transforming larvae.	3,270	2,300	278.3	277.6	—.7
	E	Feeding period of wintering larvae	929	1,532	281.0	282.4	+1.4
Cocoon (larva and pupa).	F	Cocoon period of transforming individuals.	3,431	2,270	304.6	306.7	+2.1
Life cycle (egg to adult).	G	Life cycle of transforming individuals.	3,270	2,267	694.0	694.4	+0.4
	H	Life cycle of transforming individuals (C, D, and F).[1]	(1)	(1)	[1] 692.9	[1] 695.1	+2.2

[1] This item (H) includes the records of transforming individuals which completed any stages, whereas the preceding item (G) is based on the records of those transforming individuals which completed all stages of the life cycle.

Various ranges of temperature, 50° to 84° F., 50° to 86°, 50° to 88°, and 50° to 90°, and also other ranges with 45° to 55° as the minimum, were used to determine the effective day-degrees for the several stages. In general, the 50° to 86° gave results most nearly alike for the two seasons; consequently the writers have assumed that this range comes nearest to being correct. For the sake of brevity the results of this range are the only ones presented. (Table 14.) Tables 15, 16, 17, and 19 show the extent of variation in the number of effective day-degrees needed to complete the development of the respective stages by the various individuals on the basis of a 50° to 86° range.

The average incubation periods of the eggs (Tables 14 and 15) for the two seasons, expressed in effective day-degrees, were 110° and 110.8°, respectively. Thus the difference in the average totals of effective day-degrees for the incubation period in 1925 and in 1926 was 0.8°, or a difference of less than 1 per cent.

In Tables 14 and 15 the entire incubation period is subdivided into two parts; the unobserved half day and the observed period. This is due to the method used in taking records. All deposition and hatching records were made early in the morning of each day, and experience has shown that nearly all eggs are deposited about sunset. To obtain the complete record of effective day-degrees for any lot of eggs, it was necessary to take into consideration the time and effective day-degrees occurring between the deposition and the first observation. Since it was impractical to make observations on the exact time each egg was deposited, it was estimated that an average of 12 hours elapsed for all eggs between the time of deposition and the first observation. This period has been called the unobserved half day. Consequently, to obtain the entire incubation period, it is necessary to add the unobserved half day to the observed period. The unobserved half-day period is also considered in determining the life cycle, and it is included in the figures shown in Tables 14 and 19.

TABLE 15.—*Number of eggs of the oriental peach moth which completed their incubation period within given ranges of effective day-degrees and the average number of effective day-degrees required at Riverton, N. J., seasons of 1925 and 1926*

Range of effective day-degrees	1925	1926
	Eggs	*Eggs*
80- 84.0	780	00
85- 89.0	821	630
90- 94.0	5,833	2,253
95- 99.0	12,613	6,526
100-104.9	11,484	5,601
105-109.9	6,642	5,755
110-114.9	1,665	1,825
115-119.9	16	725
120-125	356	102
Total	40,210	23,507
	Day-degrees	*Day-degrees*
Average number of effective day-degrees for observed period	99.6	102.1
Average number of effective day-degrees for unobserved half-day period	10.4	8.7
Average number of effective day-degrees for entire period	110.0	110.8

The feeding period of transforming larvae (Tables 14 and 16) averaged 278.3 and 277.6 effective day-degrees in 1925 and 1926, whereas the feeding period of wintering larvae averaged a little higher, 281 and 282.4 effective day-degrees. Again the results for the two seasons resemble each other closely, the variation being less than one-half of 1 per cent for both transforming and wintering larvae. The difference in the effective day-degree requirement of wintering and transforming larvae substantiates the results shown in Figures 12 and 13, where it is evident that wintering larvae feed longer than transforming larvae.

TABLE 16.—*Number of transforming and wintering larvae of the oriental peach moth which completed their feeding periods within given ranges of effective day-degrees, and the average number of effective day-degrees required, at Riverton, N. J., seasons of 1925 and 1926*

Range of effective day-degrees	Transforming larvae		Wintering larvae	
	1925	1926	1925	1926
	Number	*Number*	*Number*	*Number*
200-209.9	1	0	0	0
210-219.9	8	6	20	0
220-229.9	59	17	10	0
230-239.9	297	71	79	0
240-249.9	86	122	53	67
250-259.9	131	183	0	120
260-269.9	376	420	121	248
270-279.9	641	530	200	317
280-289.9	460	205	268	251
290-299.9	639	373	55	235
300-309.9	346	213	91	181
310-319.9	119	160	5	76
320-329.9	84	0	3	31
330-340.0	20	6	15	6
Total	3,270	2,309	929	1,532
	Day-degrees	*Day-degrees*	*Day-degrees*	*Day-degrees*
Average number of effective day-degrees	278.3	277.6	281.0	282.4

The cocoon period (larva, prepupa, and pupa) of transforming individuals (Tables 14 and 17) averaged 304.6 and 306.7 effective day-degrees for 1925 and 1926. This stage showed the greatest variation of all the stages for the two years, yet the difference was less than 1 per cent. P. A. Glenn has shown that the pupal stage of the codling moth has an effective day-degree range of 52 to 86. It is probable that if a similar correction could have been made the results for the two years might have been closer. Unfortunately continuous records on the pupal stage for 1925 were not made; consequently a separate zero of development for pupae could not be ascertained.

TABLE 17.—*Number of oriental peach moths which completed their cocoon periods within given ranges of effective day-degrees, and the average number of effective day-degrees, Riverton, N. J., seasons of 1925 and 1926*

Range of effective day-degrees	1925	1926
	Cocoons	*Cocoons*
255-259.9	7	0
260-269.9	116	9
270-279.9	161	40
280-289.9	311	201
290-299.9	234	502
300-309.9	772	773
310-319.9	1,595	555
320-329.9	186	174
330-334.9	49	16
Total	3,431	2,270
	Day-degrees	*Day-degrees*
Average number of effective day-degrees	304.6	306.7

The influence of effective day-degrees on wintering larvae and pupae in cocoons is different from that on transforming individuals in cocoons, for it requires many more effective day-degrees to complete the development of the stages within and produce adults. At one time it was the opinion of the writers that the average of accumulated effective day-degrees in the spring of the year, starting with January 1, would be the same for wintering material in any season. Apparently this is not the case, for after trying zeros of development from 45° to 55° F. and figuring the accumulated degrees above the zero points for each individual and averaging them for the two seasons under consideration (Table 18), it was learned that the average effective day-degree requirement for the spring of 1927 was more than 12 per cent higher than for the spring of 1926. In calculating it was learned that changes in the maximum degree of development for the spring of the year had little or no effect, for there were but two or three days when the temperature was higher than 86°.

TABLE 18.—*Average number of effective day-degrees (using various ranges) to which the wintering cocoons that produced moths were exposed during the dormant seasons of 1925–26 and 1926–27 in the insectary at Riverton, N. J.*

Effective day-degree range	Item	Dormant season: Time	1925-26	1926-27	More (+) or less (−) in 1926-27	
°F.			*Effective day-degrees*	*Effective day-degrees*	*Effective day-degrees*	*Per cent*
45-86	A	Spring	802.2	936.5	+134.3	+16.7
	B	Fall	583.1	504.0	−79.1	−13.5
	C	Both	1,385.3	1,440.5	+55.2	+3.9
50-86	D	Spring	545.0	633.3	+88.3	+16.2
	E	Fall	380.5	332.2	−48.3	−12.6
	F	Both	925.5	965.5	+40.0	+4.3
52-86	G	Spring	459.0	529.6	+70.6	+15.3
	H	Fall	325.5	273.4	−52.1	−16.0
	I	Both	784.5	803.0	+18.5	+2.3
55-86	J	Spring	349.4	394.7	+45.3	+12.9
	K	Fall	232.5	148.8	−83.7	−36.0
	L	Both	581.9	543.5	−38.4	−6.5

Since there seemed to be a more or less consistent variation in the accumulated effective day-degrees for the spring of the year for the two seasons, it was thought that the accumulated effective day-degrees in the fall of the year might have had some influence on the development of the wintering larvae; consequently these were ascertained. The effective day-degrees from the time the cocoon was constructed in the late summer or fall until January 1 was figured for each individual and the average determined for all. The averages for each zero of development are recorded in Table 18. The average of accumulated effective day-degrees for the fall of the year of 1926 is consistently less (by 12 per cent or more) for all zeros of development than in 1925. This is just the reverse of the situation in the spring of the year. This reversal indicates strongly that the accumulated effective day-degrees in the fall of the year must be taken into consideration in determining the spring-brood emergence of moths.

When the accumulated effective day-degrees for the fall and spring of the year are added together they give (for each range of effective day-degrees) all the accumulated effective day-degrees the cocoons are subjected to between the time of their formation and the emergence of the adult. It will be noted in Table 18 that the addition of the fall temperatures to the spring temperatures for each season reduces the total difference in the two seasons materially. The 52° to 86° range shows the smallest difference, which is 18.5°. This difference approximates 2 per cent for the two seasons when the entire cocoon period is considered. Since the 52° to 86° range shows the least difference in the average of accumulated effective day-degrees for the two seasons, it is assumed that 52° F. is probably the zero of development for the stages within the overwintering cocoon. This is the zero of development that Glenn established for the codling-moth pupa.

The foregoing facts on wintering cocoons of the oriental peach moth indicate strongly that in determining the spring-brood emergence the accumulated effective day-degrees in the fall of the year must be considered as well as those in the spring in determining or in forecasting the time of emergence of the spring brood.

One observation remains, however, which may or may not have an important bearing on the validity of the above statements. It has been learned that individuals which spin cocoons early in the fall do not necessarily emerge first in the spring, nor do individuals which spin cocoons late in the fall emerge correspondingly late in the spring. In fact there is some indication that larvae which spin their cocoons late in the fall are likely to produce the earliest spring-brood adults. These facts are difficult to explain in view of the information presented in regard to the influence of fall temperatures on the spring-brood emergence. It is probable that important factors other than temperature might explain the seeming inconsistency.

The entire life-cycle period (egg to adult) of transforming individuals (Tables 14 and 19) averaged 694 and 694.4 effective day-degrees for 1925 and 1926. The variation was 0.4° or less than 0.1 per cent. If the average effective day-degrees calculated for each stage, eggs (C), transforming larvae (D), and transforming cocoons (F) in Table 14 are combined, the totals are 692.9 and 695.1 effective day-degrees for the two seasons, or a variation of 2.2°, which is less than 0.4 per cent.

TABLE 19.—*Number of oriental peach moths which completed their life cycles within given ranges of effective day-degrees, and the average number of effective day-degrees required, at Riverton, N. J., seasons of 1925 and 1926*

Range of effective day-degrees	1925	1926
	Individuals	*Individuals*
585-589.9	0	24
590-599.9	0	0
600-609.9	12	5
610-619.9	14	5
620-629.9	44	17
630-639.9	121	22
640-649.9	170	61
650-659.9	331	198
660-669.9	320	278
670-679.9	156	360
680-689.9	211	278
690-699.9	402	446
700-709.9	450	177
710-719.9	452	113
720-729.9	351	177
730-739.9	233	0
740-749.9	0	88
750-759.9	0	0
Total	3,270	2,207
	Day-degrees	*Day-degrees*
Average number of effective day-degrees for observed period	683.6	685.7
Average number of effective day-degrees for unobserved half-day period	10.4	8.7
Average number of effective day-degrees for entire period	694.0	694.4

The foregoing discussion shows that the 50° to 86° F. range of effective day-degrees is approximately correct if all the individuals of a given stage for an entire growing season are taken into consideration; however, if the effective day-degrees are ascertained for a given stage in the several generations there is a slight difference in the generations. The indications are that early or late in the season an effective day-degree produces a greater development than during midseason, when high temperatures predominate. In other words, it requires a somewhat smaller total of effective day-degrees within the 50° to 86° range for the completion of the feeding period or cocoon period (not so true of the incubation period) early or late in the year, when the night temperatures fall below 50°, than during midsummer, when all temperatures are much above 50°.

It is possible that the zero of development for the oriental peach moth may be somewhat below 50° F. for some of the stages, particularly the feeding period and possibly the cocoon period of transforming individuals. Shelford in his investigations (*15*) shows that temperatures as low as 45° are to some extent effective in the development of certain stages of the codling moth. If this is also true of the oriental peach moth, it may help to explain the apparent difference in the effective day-degrees required (within the 50° to 86° range) for development of individuals existing in temperatures which average high or low.

SUMMARY

Eggs of the oriental peach moth are deposited on smooth surfaces. In the insectary eggs may be found on the smooth surface of glass, wood, or foliage (pear, apple, peach, quince, etc.). Under orchard conditions eggs are found on the lower surface of peach foliage, usually on the upper surface of apple and quince foliage, on either the upper or lower surface of pear foliage, and also on any smooth portion of newly formed twigs of peach and pear.

From 15 to 48 hours before the newly formed larva hatches, its head can be seen inside the eggshell. This is called the "black-spot" stage.

The incubation period of the egg ranges from 3½ to 20 or more days, depending upon the temperature, being shortest during the summer and longer in the spring and fall.

Larvae transforming during the summer require 6 to 24 (or an average of 12) days to complete their growth, while wintering larvae have a slightly longer feeding period and may require as many as 50 to 115 days. There are four or five larval instars, depending upon the rate of growth of the larva.

The cocoon is usually constructed in 24 to 48 hours. Summer cocoons are more fragile than the wintering forms. The cocoon period for transforming individuals is 8 to 33 days or an average of about 14 days, while the wintering cocoon period varies between 131 and 307 days.

The prepupal stage during the summer averages 3 or 4 days. Larvae cocooning late in August and during September are usually overwintering if they do not pupate within 5 to 7 days.

The length of the pupal stage for transforming individuals is 7 to 13 days or an average of nearly 10 days, and for wintering individuals which pupate in the spring it is considerably longer, 17 to 51 days or an average of about 27 days.

The adult is a small grayish-brown moth with a wing spread of approximately one-half inch. Males and females resemble each other closely. The average length of life when they are confined in glass jars is 14 or 15 days or longer. Egg deposition begins 2 to 5 days after emergence and continues for 7 to 10 days or longer. Females deposit 100 to 200 or more eggs.

Temperature and sunlight have considerable influence upon adult emergence.

The life cycle of transforming individuals averaged 30 to 33 days for the two seasons, and the average for wintering individuals was 278 and 279 days for the two winters.

In 1925 there were five complete or partial generations at Riverton N. J., and in 1926 there were four complete or partial generations.

The marked difference in the temperature during the two seasons (1925 and 1926) was chiefly responsible for the decided difference in the number of generations and the dates when the various stages in the several generations occurred. The season of 1926 was considerably cooler than the preceding season and from May 1 to September 30, 1926, there were 333.3 effective day-degrees less than for the same period in 1925.

The work of P. A. Glenn indicates that in general the effective temperatures for the development of the codling moth exist between 50° and 86° F. Although the two seasons of 1925 and 1926 were so extremely different from the standpoint of temperature, the application of Glenn's ideas and theories to the oriental peach moth indicate that the 50° to 86° range is approximately correct for this insect. This further emphasizes the close relationship existing between the codling moth and the oriental peach moth. The variation in the number of effective day-degrees required to complete the development of each stage (egg, larva, and cocoon, including pupa) in the life cycle of the oriental peach moth did not exceed 1 per cent for the two seasons.

The average accumulated effective day-degree requirement for the fall of 1926 was found to be consistently less (12 per cent or more) for all zeros of development than that for the fall of 1925. Conversely, the average effective day-degree requirement for the spring of 1927 was more than 12 per cent higher than that for the spring of 1926. Thus, in the case of wintering larvae the effective day-degrees in the fall of the year as well as those occurring in the spring must be taken into consideration in determining the spring-brood emergence of moths. A temperature of 52° F. is probably the zero of development for the stages in the overwintering cocoon. Although the 50° to 86° range of effective day-degrees is approximately correct if all the individuals of a given stage for an entire growing season are taken into consideration, there is a slight difference in the generations when the effective day-degrees are ascertained for a given stage in the several generations. It is possible that the zero of development for the oriental peach moth may be somewhat below 50° for some stages, particularly the feeding period and possibly the cocoon period of transforming individuals.

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