Relation of Temperature to the Growth of the Oriental Peach Moth. I.

By

Chukichi Harukawa.

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Introduction.

In a previous report[1] the writer pointed out that the oriental peach moth occurs two to five times a year according to the climate of the locality where this insect is found. The results of later laboratory experiments in Kurashiki have shown that it sometimes appears six times, the sixth being a partial brood.

Even in Okayama Prefecture the number of broods in a year seems to vary according to the weather condition. Thus, MATSUMOTO observed that the oriental peach moth appeared four times in his rearing experiments at the Okayama Agricultural Experiment Station.[2] The writer could ascertain by the rearing experiments in the insectary in 1924 that some individuals of the fourth generation entered into hibernation although the others completed another generation.

In view of these facts the writer desired to study the rate of the growth of the oriental peach moth at various temperatures.

Part I. Experiments at Variable Temperatures.

In 1923 and 1924 rearing experiments were carried on in the insectary. Petri-dishes were used as the containers in which to rear the larva. Each container contained only one egg or one larva as the case may be and the time of hatching, of the maturity of the larva and the time of the emergence of moth were recorded. The windows of the insectary were left wide open to keep the temperature and humidity of the insectary as closely similar to the outdoor condition as possible.

A maximum and minimum thermometer was hung on the wall of the insectary and the temperature was recorded. The mean daily temperature during the period of a generation was calculated from this record.

The mean number of days required for one generation, the mean temperature for respective generation and the velocity or the rate of the development which were obtained in the experiments are shown in the accompanying table. (Table I)

Table I.

Results of Variable Temperature Experiments.

Generation.	Average Temperature (C).	Average Number of Days Required for a Generation.	Relative Velocity of Growth.
1st Gen. 1924	18.2°	44.1	0.022
2nd Gen. 1923	22.5°	30.0	0.033
2nd Gen. 1924	24.6°	24.8	0.040
5th Gen. 1923	26.2°	22.2	0.045
3rd Gen. 1923	26.3°	22.0	0.045
3rd Gen. 1924	28.3°	20.7	0.048
4th Gen. 1923	29.1°	19.9	0.050

As seen in the above table the duration of a generation differs greatly according to temperature. The first generation which appears in May to early June takes more than fifty-four days while the fourth brood which appears mostly in August, when the air temperature is the highest, requires only about nineteen days. Thus, it will be expected that a slight shifting in the time of appearance of the first brood in the spring may produce a considerable change in the time of a later brood.

The appearance of the moth in the spring occurs during quite a long period, sometimes covering more than twenty or even thirty days.

Considering these circumstances, it is easily understood that some individuals of the oriental peach moth may appear four times while others may produce five or even six generations in the same year in the same locality.

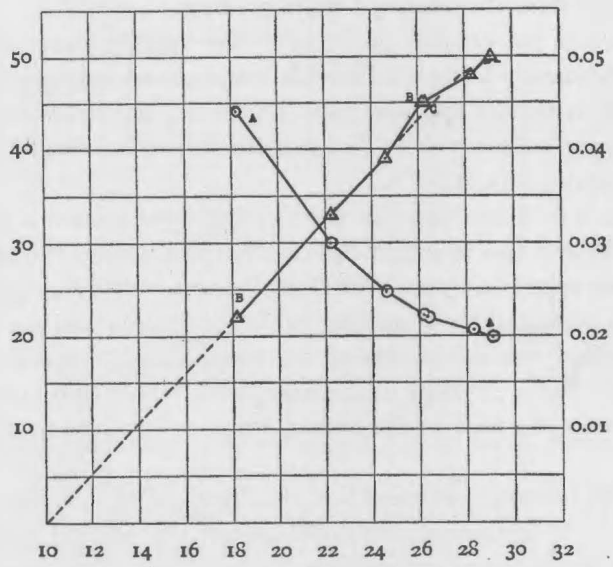
Relation between Temperature and the Rate of Development.

Strictly speaking, the rate of development may not necessarily be the same in different stages of metamorphosis. Therefore, the rate of development in the egg, the larval and the pupal stage has to be treated separately. The writer, however, considered the three stages together, since the object of the writer was to know approximate relationship between the rate of growth and temperature.

The relative velocity of development was obtained by dividing unity by the number of days required for completion of one generation. The values obtained by this method are shown in Table I.

Taking the number of days required for one generation and the velocity values on the ordinate and the temperature on the abscissa, the curves as shown in Figure 1 have been obtained.

Fig. 1.



A Time-temperature curve.
B Velocity curve.
C Corrected velocity curve.

As to the nature of the curves obtained in this way opinions of investigators are different. Some authors consider that the curve A, i. e., the time-temperature curve, is an equilateral hyperbola, the velocity curve being its reciprocal while some others maintain that it is not a hyperbola, and that it is rather of a nature of an exponential curve. Recently JANISCH[3] expressed his view that the time-temperature curve is a catenary resulting from the combination of two kinds of exponential curve.

As a matter of fact the time-temperature curve is not a true hyperbola for all the range of temperatures at which the development of insect is possible. The writer has now no intention to state which of these theories represents the truth. For the present, however, he assumes, in the interpretation of the results of his experiments, that the time-temperature curve is a hyperbola. According to this theory there must be a temperature for each insect below which development ceases. In most cases the temperature at which development really comes

to a standstill is not easily determined. However, the theoretical threshold of development can approximately be located by extending the straight line part of the velocity curve. The threshold thus obtained has, however, no biological significance as pointed out by SHELFORD[4] since development usually goes on at this temperature with a quite significant velocity.

If the time-temperature curve conforms to an equilateral hyperbola, we have, as a consequence, the relationship that the total sum of the effective temperatures during the period required for the completion of a stage is a constant at whatever temperature the development may occur.

In the case of the oriental peach moth the velocity curve experimentally obtained is very nearly a straight line for temperatures approximately between 18° and 27° C as will be apparent from Figure 1. By extending the straight line part of the velocity curve we find that the theoretical threshold of development lies approximately at 10° C.

SHELFORD has shown that the threshold of development is not always the same for all three stages in metamorphosis, nor is it always the same for all the generations that appear in a year. Similarly the accumulated temperatures varies, though within certain limits according to the generation and the climatic condition. Therefore, the calculation of the accumulated temperature should be made separately for each stage in metamorphosis taking into consideration the climatic condition, the time of the season, etc. if an accurate result is to be obtained.

The writer, however, assumed that the threshold of development is 10° C for all the stages in metamorphosis in the case of the oriental peach moth and calculated the accumulated temperatures for one generation, since the object of the writer in this part of the paper was to show only an approximate relationship.

Table II.

Average Accumulated Effective Temperatures for the Oriental Peach Moth.

Generations.	Average Temperature. (C)	Average Accumulated Temperatures in Degree-Days.
1st Gener. 1924	18.2°	358.3
2nd Gener. 1923	22.5°	377.7
2nd Gener. 1924	24.6°	358.8
5th Gener. 1923	26.2°	371.5
3rd Gener. 1923	26.3°	356.8
3rd Gener. 1924	28.3°	380.1
4th Gener. 1923	29.1°	382.3

The accumulated temperatures in Table II are the averages of the results of about ten experiments.

Various conditions seem to have exerted an influence upon the writer's rearing experiments, so that the writer could not obtain very uniform results. However, the mean values of the accumulated temperatures required for each generation are fairly similar to one another between 18.2° and 26.3° C. At temperatures higher than 26.3° C the values of the accumulated temperatures become slightly larger. These facts as well as the shape of the velocity curve shown in Figure 1 seem to indicate that 18.2° C and 26.3° C are within the range of the so-called medial temperatures for the oriental peach moth and that the higher limit of the medial temperatures lies at a point a little lower than 28° C. The mean value obtained by averaging the accumulated temperatures for the range of 18.2° to 26.3° C is 364.6 degree-days. This may be considered the constant of that part of the time-temperature curve which conforms to a hyperbola.

In the above discussion the writer has made several assumptions, namely, that the relation of the rate of development to temperature is similar in three stages in metamorphosis, that a certain part of the time-temperature curve conforms to a hyperbola and also that the threshold of development is 10° C for all three stages.

However, as has been already pointed out, the relation of the rate of development to temperature is not necessarily the same in the egg, the larval and the pupal stage. Moreover, the time-temperature curve does not seem to conform to a hyperbola strictly speaking. The writer, therefore, carried out another series of experiments under the condition of various constant temperatures to compare their results with those of the experiments described above and to study the rate of the development of the egg, the larva and the pupa separately.

Part II. Experiments at Constant Temperatures.

Methods of Experimentation and the Calculation of Average Temperature.

The method of experiment in the study of the influence of the climatic factors on insect development has experienced a great progress in recent years and it is becoming more and more exact and complicated. If it is desired to study the effect of temperature on insect development, it is necessary to carry on experiments under constant temperature keeping the other climatic factors such as relative humidity, evaporation, etc. constant. This is, however, not sufficient. It is maintained by some investigators that experiments should be carried out under such conditions of variable temperature, relative humidity, etc. that prevail under the natural habitat of the insect in question.[4)]

The writer, however, is not able to avail himself of such a complicated equipment. Therefore, the writer has studied the effect of temperature using ordinary constant temperature incubators. Attention was paid to the relative humidity in the incubators. Thus, rearing was carried on in Petri-dishes, on the inside of the cover a small piece of blotting paper was attatched. This blotting paper was moistened with a few drops of water when it is necessary. It is believed that in no case the relative humidity inside was lower than about 65 or 70 per cent., nor was it higher than about 95 per cent.

Since the egg of the oriental peach moth is laid on the peach leaf and the larva bores into the young shoot, the egg would absorb moisture from the leaf and the larva is probably not much influenced by the outside relative humidity. Under these circumstances the results of the experiments could not have been much influenced by the relative humidity of the incubators. Still the results obtained by the writer must be considered to show only an approximate relationship between the temperature and development since it can not be proven that there was no effect of relative humidity at all on the rate of growth.

Recently it has been shown by KOGURE[5] that light has an important effect upon the voltinism of the silk-worm. It was already suspected, before this result was published, that light may have some effect on the hibernatoin of insect. Therefore, the incubators which were used in the writer's experiments were constructed in such a way that the front or the right and left side were provided with glass windows.

In an incubator of a considerable size, the temperature inside shows quite a marked difference between the top and the bottom. Therefore, a small electric fan was placed in the incubator to agitate the air inside the incubator.

Calculation of the Average Temperature during an Experiment.

On account of an accident or of some other causes it sometimes happens that the temperature of the incubator shifts to some extent from the appointed temperature. Therefore, a recording thermometer was placed in each incubator to record this change in temperature. By consulting the recording sheets, it was possible to know the extent of change in temperature and the duration of this change, and to calculate thereby the average temperature during an experiment. The hourly average was obtained for each stage in metamorphosis separately.

The developmental period was divided into three parts : the egg period, the growing period and the cocoon period. The writer did not try to determine the time of pupation since the writer did not desire to disturb the larva in cocoon. The growing period means the period from the hatching of an egg to the spinning of a cocoon and the cocoon period is from the time of finishing a cocoon to the emer-

gence of an adult insect.

Since it was not possible to examine the Petri-dishes containing the insects very often during a day, the writer made the following assumption :

1. The egg period is from five o'clock p. m. to twelve o'clock p. m. of the day before hatching.

2. Hatching is assumed to occur at midnight. The growing period is, therefore, from the time of hatching to twelve o'clock p. m. of the day of spinning a cocoon.

3. The emergence of moth is assumed to occur at noon. The cocoon period is, therefore, from the time of spinning to the noon of the day of emergence.

It is needless to state that the actual time was used for calculation just when hatching, spinning etc. happened was known.

The duration of each stage was first determined in hours. Then, it was transformed into day units by dividing by twenty-four. The number of days thus obtained was used for calculation of relative velocities, accumulated temperatures, etc.

As will be seen in the appendix, the average duration in hours of each stage at various constant temperatures showed, in a few cases, a variation of more than twenty-four hours. Many factors must have been responsible for this variation. The most important of these factors must have been the insufficiency in the frequency of observations made to determine the time of hatching, spinning, etc.

Range of Temperature for the Growth of the Oriental Peach Moth and the Death Rate at Various Temperatures.

In the experiments here presented, the writer was not able to carry on rearing at a constant temperature lower than 14° C. Therefore, it was thus far not possible to determine the temperature at which development ceases.

If it is assumed that the time-temperature curve conforms, at least in the medial range of temperatures, to a hyperbola, the theoretical threshold can be determined for each stage in metamorphosis. However, if it is assumed that the time-temperature curve is a catenary, there can be no such point as the theoretical threshold of development in the sense as used heretofore. The lowest temperature at which metabolic activity is possible may be designated the actual threshold. This temperature would be very difficult to determine experimentally.

In the first part of this paper, the writer assumed that the time-temperature curve is a hyperbola and stated that the theoretical threshold of the oriental peach moth is adout 10° C. According to the experiments reported in the present part of the paper, the theoretical threshold of the development of the

egg and also of the larva is approximately 10° C, and that of the cocoon stage is slightly higher, namely, approximately 10.4° C.

The writer was not able to determine exactly the highest limit of the temperature where development is possible. At a constant temperature of 35.5° C a small percentage of the eggs hatched, but the development of any other stage was not possible. The death point of the egg seems to be the highest of the three stages. Thus, more than 60 per cent. of the eggs hatched at 34.5° C, but no larva could survive this temperature. At 34° C only a small percentage could reach maturity and emerged as adult insects.

The death rate of any stage increased markedly when temperature reached 33° C. The death rates as observed in various constant temperature experiments are shown in Table III.

Table III.

Death Rates at Various Temperatures.

Number of Indiv. Reared.	Temperature C.	Dead Eggs		Dead Larvae		Dead Pupae		Total Death Rates %
		Number	Per Cent.	Number	Per Cent.	Number	Per Cent.	
86	20°	0	0	12	14	0	0	14
66	25°	0	0	13	19.7	2	3.0	22.7
53	25°	0	0	11	20.8	7	13.2	34.0
63	27°	0	0	8	12.6	2	3.1	15.7
42	30°	0	0	—	—	9	21.4	—
42	30°	0	0	3	7.1	6	14.2	21.3
31	33°	0	0	—	—	9	29.0	—
32	33°	1	3.1	13	40.6	3	9.3	53.0
27	33°	0	0	6	22.2	13	48.1	70.3
48	34°	5	10.4	39	81.2	2	—	95.7
16	34.5°	10	62.5	6	(100)	—	—	100
27	35.5°	24	88.9	3	(100)	—	—	100

From the record shown in Table III it will be seen that no individual can reach the pupal stage when the temperature is 34.5° C. A constant temperature of 33° C is injurious to the larva of the oriental peach moth when this temperature acts upon the larva continuously.

As it has been stated already, the humidity was not kept constant in these experiments. However, the writer believes that relative humidity did not much influence the results of these experiments. In a previous paper[1] the writer published the results of his experiments on the effect of relative humidity on the development of the egg and the pupa of the oriental peach moth. In these

experiments the writer kept the relative humidity constant by the aid of the sulphuric acid solutions of various vapour tension. The results of the experiments are cited here for comparison. (Tables IV and V)

Table IV.

Effect of Relative Humidity on the Development of the Egg of the Oriental Peach Moth.

Relative Humidity	Number of Eggs Used.	Number of Eggs Hatched.	Per Cent. of Eggs Hatched.
10	97	47	49.4
35	83	69	83.1
65	49	49	100

Table V.

Effect of Relative Humidity on the Emergence of the Adult.

Relative Humidity	Number of Pupae Used.	Number of Adults Emerged	Per Cent. of Emergence.
10	36	24	66.6
35	32	31	96.8
65	35	33	94.3

From the results in the above tables, it is apparent that even under a very dry condition of 10 per cent. about 50 per cent. of the eggs hatched and more than 60 per cent. of the pupae transformed to adult insects. When the relative humidity was 35 per cent., more than 80 to 90 per cent. developed. Taking these facts into consideration, the writer believes that in the present experiments dryness of air had perhaps little effect on the death rate of any stage.

Effect of Temperature on the Rate of Development.

The results in the experiments here reported were not satisfactorily accurate, so that it is at the present time difficult to arrive at a definite conclusion based upon these results.

The results obtained at temperatures of 14.9° to 17.4° C are included in Tables VI to VIII. These temperatures, however, were not constant in the strict sense, but varied within a few degrees. It is meant that the average was 14.9°, 16.9° C etc., respectively. These results were included because they were in fairly good agreement with those obtained at the other temperatures which were constant or very nearly so. The figures shown in the following tables are

the averages of the results of many experiments.* As it has already been stated, the duration of each stage was first calculated in hour units. It was, then, divided into twenty-four and shown in day units. The relative velocity is the reciprocal of the duration in days.

Table VI.

Egg Period.

Temperature. C.	Egg Period in Days.	Relative Velocities	Accumulated Effective Degree-Days
32.8°—33°	3.3	0.3030	77.0
32.5°	3.3	0.3030	74
32.2°—32.3°	4.1	0.2439	92.8
31.0°—31.3°	3.2	0.3125	68.4
30.6°—30.8°	3.1	0.3164	65.7
29.3°—29.4°	3.2	0.3125	62
28.3°—28.5°	3.3	0.3030	61.7
26.0°—26.1°	4.0	0.2500	65.2
24.4°—24 6°	4.2	0.2381	61.7
20.2°—20.5°	6.2	0.1613	64.8
14.9°	12.9	0.0077	64.0

Theoretical threshold ... ... 10° C.

Table VII.

Growing Period

Temperature. C.	Growing Period in Days	Relative Velocities	Accumulated Effective Degree-Days
33°	10.8	0.0926	248.4
32.6°—32.8°	8.7	0.1149	198.4
32.1°	9.8	0.1020	218.5
31.5°—31.7°	9.5	0.1052	202.5
29.8°—30.0°	8.6	0.1162	173.6
29.0°—29.3°	7.2	0.1388	139.6
27.0°—27.1°	9.0	0.1111	150.2

* For the detailed records of the results the readers are referred to the appendix at the end of this paper.

Temperature. C.	Growing Period in Days	Rerative Velocities	Accumulated Effective Degree-Days
25.0°	10.3	0.0971	157.6
20.0°	15.4	0.0649	153.9
16.9°—17.0°	21.8	0.0458	153.7

Theoretical threshold ... ... 10° C.

Table VIII.

Cocoon Period.

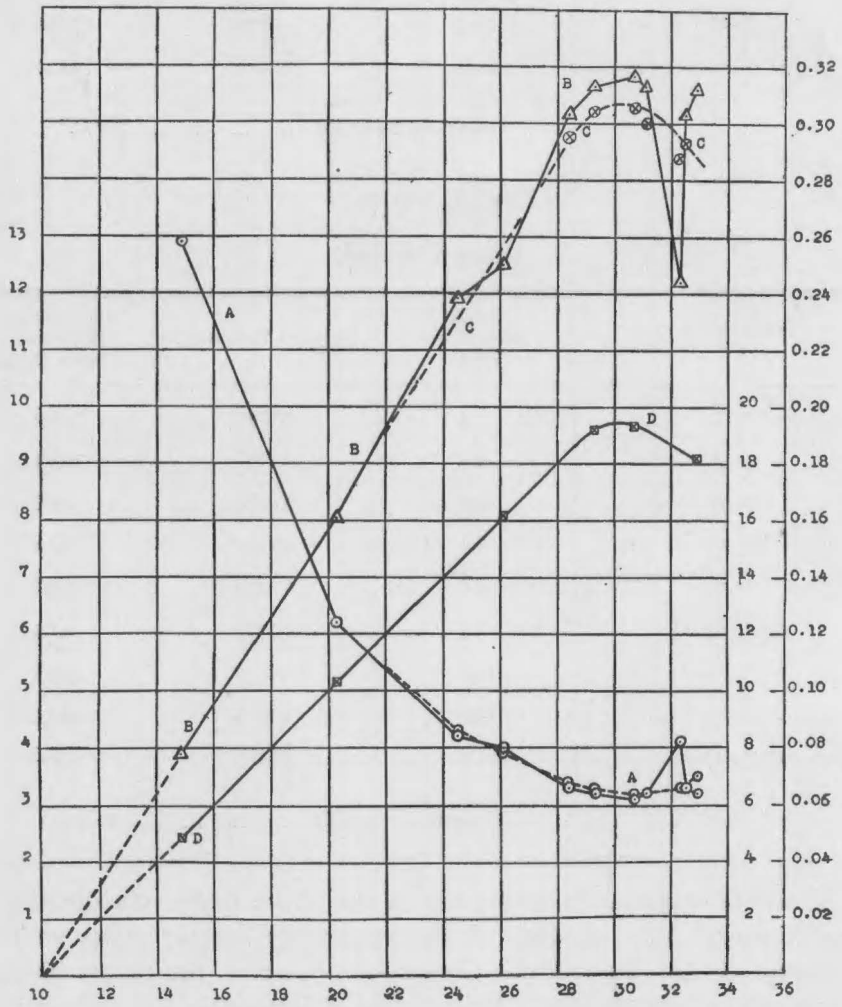
Temperature. C.	Cocoon Period in Days.	Relative Velocities.	Accumulated Effective Degree-Days.
33°	8.4	0.1190	190.6
31.5°	9.1	0.1098	193.4
30.0°	7.2	0.1388	140.9
29.0°	8.9	0.1123	166.1
27.5°	8.0	0.1250	137.8
26.8°—27.0°	8.5	0.1176	141.3
24.9°—25.0°	10.0	0.1000	146.5
20.0°	14.6	0.0685	140.3
17.1°—17.4°	21.5	0.0465	148.6

Theoretical threshold ... ... 10.4° C.

As will be apparent from the data in the above tables, the duration of stages decreased fairly regularly as the temperature became higher until approximately 28° C. Beyond this temperature, however, the results obtained were not satisfactorily regular. Nevertheless, it is possible to see from these results a fairly regular tendency.

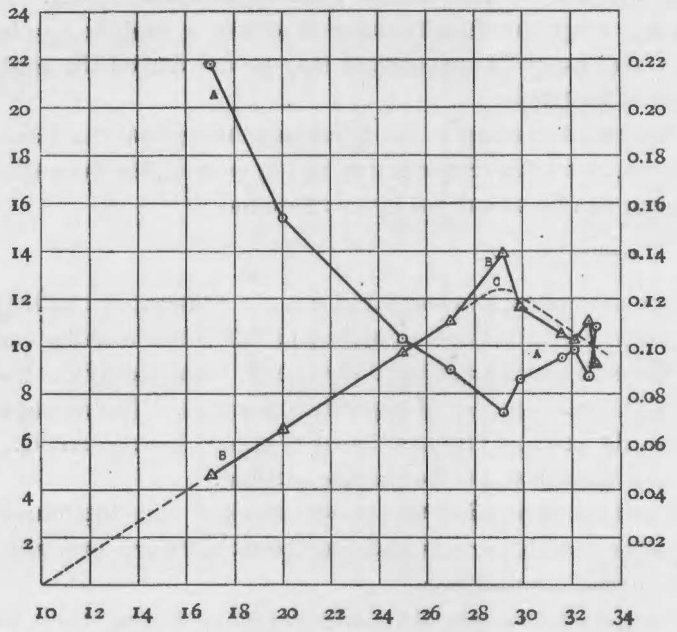
Figures 2 to 4 were drawn using the data in the above tables.

Fig. 2.



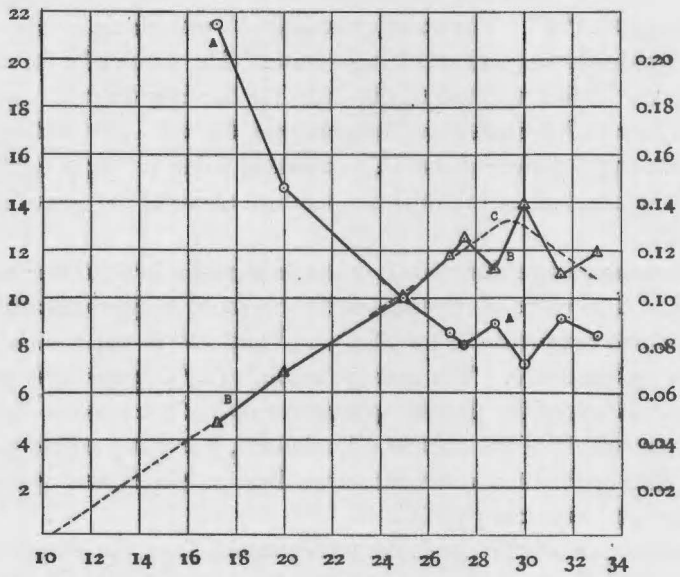
Time-temperature curve (A) and velocity curve (B, C) of egg stage.

Fig. 3.



Time-temperature curve (A) and velocity curve (B, C) of growing stage.

Fig. 4.



Time-temperature curve (A) and velocity curve (B, C) of cocoon stage.

The velocity curve of any stage very nearly conforms to a straight line between about 15° and 28° C as will be apparent from the figures.

In the egg stage the velocity curve is almost a straight line between 15° and 28° C. This range of temperature may be considered the medial range of temperatures of SHELFORD.

If we assume, according to the hyperbola theory, that the time-temperature curve conforms, at medial temperatures, to a hyperbola, the theoretical threshold of development can be calculated by the formula

$$(x_1' - a)y = k$$

where a is the theoretical threshold and k is the constant of this hyperbola.

The values of a calculated according to this formula using various values of y which were obtained experimentally should theoretically be the same, but they differ slightly on account of experimental errors. The average value of a obtained with the method just mentioned is approximately 10° C. The value of a may be obtained also by the graphic method.

In the present discussion the writer assumed that the time-temperature curve is an equilateral hyperbola so far as the temperature does not exceed the limits of the medial temperatures.

In the egg stage the sum of the effective temperatures within the range of the medial temperatures is from 61.7 to 65.2 degree-days as shown in Table VI. The average of these accumulated temperatures is 63.4 degree-days which may be considered the constant of that part of the time-temperature curve which conforms to a hyperbola.

In the growing stage the velocity curve is very nearly a straight line between 17° and 28.3° C. The velocity reaches its maximum at about 29.2° C, decreasing gradually beyond this temperature. The value of a for this stage as obtained by the similar method to that used for the egg stage is approximately 10° C. The sum of the effective temperatures for 20°, 25° and 27° C varies from 150.2 to 157.6 degree-days. The average value is 153.9, which may be considered the constant of the time-temperature curve of the growing period of the larva.

In the cocoon stage the velocity curve is almost a straight line between 17° and 26.7° C. The value of the theoretical threshold is approximately 10.4° C. The accumulated temperatures for 26.9°, 25° and 20° is 141.3, 146.5 and 140.3 degree-days, respectively. The average value, 142.7 degree-days, may be considered the constant of the time-temperature curve of the cocoon stage.

From the results of the present experiments, it is not possible to determine the lowest limit of the medial temperatures since no experiment was conducted at a temperature lower than 14° C.

In the first part of this paper the writer stated, from the results of the experiments at variable temperatures, that the theoretical threshold of the development of the oriental peach moth is approximately 10° C and that the average

of the accumulated temperatures for a generation is 364.6 degree-days. This value was obtained assuming the same threshold of development for all stages in metamorphosis. The calculation of the total of effective temperatures in such an assumption does not give the correct total. The value obtained would be slightly larger than what it really should be. There was another factor which made the totat of the effective temperatures in the variable temperature experiments larger than the correct value. It was the method which the writer used in obtaining the mean daily temperature. In the variable temperature experiments the writer was not able to use a recording thermometer. The mean temperature was calculated by dividing the sum of the maximum and the minimum temperature into two. This method should give, in this locality, a slightly larger figure than the correct daily mean. Therefore, the total of the effective temperatures calculated being based upon these mean daily temperatures must have been larger than the real value.

It must have been due to these circumstances that the total of the accumulated effective temperatures obtained in the variable temperature experiments was apparently slightly larger than that obtained in the constant temperature experiments. SHELFORD stated that development goes on a little faster at variable temperature than at constant temperature. That this is not apparent in the results of the writer's experiments would have been due probably to the method of calculation of accumulated temperatures as has been mentioned above.

Summary and Conclusion.

The results of the experiments conducted to study the relation of temperature to the development of the oriental peach moth are reported in the present paper.

The experiments were caried out at variable as well as at constant temperatures and the results obtained in two cases were compared.

A temperature lower than about 14° C was not available, so that the writer was not able to determine the effect on the oriental peach moth of temperatures lower than 14° C.

The maximum temperature for the development of the egg stage seems to be a little higher than those of the larval or of the pupal stage.

Continued exposure to a constant temperature of 33° C or higher seems to be injurious to any stage of this insect and the death rate at 33° C may sometimes exceed 70 per cent.

When three stages in metamorphosis are taken as a whole, the effect on the rate of development of the constant temperature and of the variable temperarure was fairly similar in our experiments.

As to the relation of temperature to the rate of development, opinions of

investigators are not in agreement. While certain authors consider that the curve showing the relation of temperature to the time required for the completion of a stage is a hyperbola at least in a certain range of temperatures, others maintain that the relation between the velocity of development and temperature is expressed by the formula showing the relation of the velocity of chemical reaction to temperature.[6] Still others consider that the time-temperature curve is a catenary.

It can not be denied that the first theory does not hold good for all the temperature range in which growth is possible, since the time-temperature curve does not conform to a hyperbola outside the so-called medial temperature range.

The writer does not know which of these theories represents the truth. For the present, however, the writer assumed that the first theory holds good at least within the range of medial temperatures and calculated accumulated temperatures.

Although the lowest limit of the range of medial temperatures can not be determined from the results of the present experiments, a temperature of 15° C undoubtedly lies within the medial range.

The mean value of the accumulated temperatures of the egg stage is 63.4 degree-days, that of the growing stage, 153.9 degree-days and that of the cocoon period , 142.7 degree-days.

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6) ROBERTSON, T. B. Principles of Biochemistry for Students of Medicine, Agriculture and Related Sciences. Pp. 471—483, 1924.

N. B. The writer published in " Nôgaku Kenkyu " a paper in Japanese on the relation of constant temperature to the growth of the oriental peach moth which is based on the same data of the present paper. In view of conflicting opinions in regard to the nature of the time-temperature curve in insect development, the writer found it necessary to retain and also somewhat to modify his opinion on certain points.

Acknowledgments.

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Appendix.

Records of Constant Temperature Experiments.

Egg Period.

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
32.8°	79	2597.0	1926 No. 11
〃	79	2597.0	〃 No. 17
32.9°	79	2601.9	〃 No. 1
〃	79	2601.9	〃 No. 4
〃	79	2601.9	〃 No. 5
〃	79	2601.9	〃 No. 6
〃	79	2601.9	〃 No. 7
〃	79	2601.9	〃 No. 8
〃	79	2601.9	〃 No. 9
33.0°	79	2608.5	〃 No. 24
〃	79	2608.5	〃 No. 28
〃	79	2608.5	〃 No. 29
〃	79	2608.5	〃 No. 30
〃	79	2608.5	〃 No. 31
	Average 79±0.00	Average. 2608.5	
32.5°	79	2569.7	1925 No. 9
〃	79	2569.7	〃 No. 10
〃	79	2569.7	〃 No. 11
〃	79	2569.7	〃 No. 12
〃	79	2569.7	〃 No. 13
〃	79	2569.7	〃 No. 14
〃	79	2569.7	〃 No. 18
〃	79	2569.7	〃 No. 20
〃	79	2569.7	〃 No. 21
〃	79	2569.7	〃 No. 22
〃	79	2569.7	〃 No. 23
〃	79	2569.7	〃 No. 24
〃	79	2569.7	〃 No. 25
〃	79	2569.7	〃 No. 26
〃	79	2569.7	〃 No. 27
〃	79	2569.7	〃 No. 28
〃	79	2569.7	〃 No. 29
〃	79	2569.7	〃 No. 30
〃	79	2569.7	〃 No. 31
〃	79	2569.7	〃 No. 33
	Average. 79±0.00	Average 2569.7	

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
32.2°	79	2551.3	1926(A) No. 8
〃	79	2551.3	〃 No. 9
〃	79	2551.3	〃 No. 10
〃	79	2551.3	〃 No. 11
〃	79	2551.3	〃 No. 12
〃	103	3325.0	1926(B) No. 12
〃	103	3325.0	〃 No. 20
32.3°	55	1769.0	〃 No. 21
〃	55	1769.0	〃 No. 22
〃	103	3336.5	〃 No. 34
〃	127	4093.5	1927 No. 9
〃	127	4093.5	〃 No. 10
〃	127	4093.5	〃 No. 11
〃	127	4093.5	〃 No. 12
〃	127	4093.5	〃 No. 13
〃	127	4093.5	〃 No. 14
〃	127	4093.5	〃 No. 16
〃	127	4093.5	〃 No. 19
〃	127	4093.5	〃 No. 20
〃	127	4093.5	〃 No. 21
〃	127	4093.5	〃 No. 22
〃	55	1769.0	1926(B) No. 13
〃	55	1769.0	〃 No. 14
〃	55	1769.0	〃 No. 16
〃	127	4093.5	1927 No. 15
	Average. 100.1±19.6	Average. 3228.4	
31.0°	79	2456.3	1925 No. 1
〃	79	2456.3	〃 No. 2
〃	79	2456.3	〃 No. 3
〃	79	2456.3	〃 No. 4
〃	79	2456.3	〃 No. 5
〃	79	2456.3	〃 No. 7
〃	79	2456.3	〃 No. 8
〃	79	2456.3	〃 No. 9
〃	79	2456.3	〃 No. 10
〃	79	2456.3	〃 No. 11
〃	79	2456.3	〃 No. 13

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
31.1°	55	1715.0	1925 No. 6
〃	55	1715.0	〃 No. 12
〃	79	2459.5	〃 No. 14
〃	79	2459.5	〃 No. 15
〃	79	2459.5	〃 No. 16
〃	79	2459.5	〃 No. 17
〃	79	2459.5	〃 No. 18
〃	79	2459.5	〃 No. 19
〃	79	2459.5	〃 No. 20
〃	79	2459.5	〃 No. 21
〃	79	2954.5	〃 No. 22
〃	79	2459.5	〃 No. 23
〃	79	2459.5	〃 No. 24
〃	79	2459.5	〃 No. 25
〃	79	2459.5	〃 No. 26
〃	79	2459.5	〃 No. 28
〃	79	2459.5	〃 No. 29
〃	79	2459.5	〃 No. 30
〃	79	2459.5	〃 No. 31
〃	79	2459.0	1927 No. 23
〃	79	2459.0	〃 No. 24
〃	79	2459.0	〃 No. 25
〃	79	2459.0	〃 No. 26
〃	79	2459.0	〃 No. 27
〃	79	2459.0	〃 No. 28
〃	79	2459.0	〃 No. 29
〃	79	2459.0	〃 No. 30
〃	79	2459.0	〃 No. 31
〃	79	2459.0	〃 No. 32
〃	79	2459.0	〃 No. 33
	Average 77.8±3.8	Average 2421.9	
30.6°	79	2420.4	1927 No. 1
〃	79	2420.4	〃 No. 4
〃	79	2420.4	〃 No. 5
〃	79	2420.4	〃 No. 6
〃	79	2420.4	〃 No. 7
〃	79	2420.4	〃 No. 8
30.8°	55	1683.8	1926 No. 26
〃	55	1683.8	〃 No. 27
〃	79	2439.9	〃 No. 30
〃	79	2439.9	〃 No. 31
30.8°	79	2439.9	1926 No. 32
〃	79	2439.9	〃 No. 34
〃	79	2439.9	〃 No. 36
〃	79	2439.9	〃 No. 37
〃	79	2439.9	〃 No. 38
〃	79	2439.9	〃 No. 39
	Average 76±5.4	Average 2338.0	
29.9°	79	2362.3	1925 No. 1
〃	79	2362.3	〃 No. 2
〃	79	2362.3	〃 No. 3
〃	79	2362.3	〃 No. 4
〃	79	2362.3	〃 No. 5
〃	79	2362.3	〃 No. 6
〃	79	2362.3	〃 No. 7
〃	79	2362.3	〃 No. 8
〃	79	2362.3	〃 No. 9
〃	79	2362.3	〃 No. 10
〃	79	2362.3	〃 No. 11
〃	79	2362.3	〃 No. 12
〃	79	2362.3	〃 No. 13
〃	79	2362.3	〃 No. 14
〃	79	2362.3	〃 No. 15
〃	79	2362.3	〃 No. 16
〃	79	2362.3	〃 No. 17
〃	79	2362.3	〃 No. 18
30.1°	79	2381.0	1925(A) No. 5
〃	79	2381.0	〃 No. 6
〃	79	2381.0	〃 No. 7
〃	79	2381.0	〃 No. 8
〃	79	2381.0	〃 No. 9
〃	79	2381.0	〃 No. 10
〃	79	2381.0	〃 No. 11
〃	79	2381.0	〃 No. 12
〃	79	2381.0	〃 No. 14
〃	79	2381.0	〃 No. 15
〃	79	2381.0	〃 No. 16
〃	79	2379.1	〃 No. 19
	Average 79±0.0	Average 2369.7	
29.3°	79	2321.2	1926 No. 25 ♀

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
29.3°	79	2321.2	1926 No. 26 —
〃	79	2321.2	〃 No. 27 —
〃	67	1964.1	〃 No. 46 ♀
〃	72	2115.2	〃 No. 61 ♀
〃	72	2115.2	〃 No. 62 ♂
〃	72	2115.2	〃 No. 63 —
29.4°	79	2324.7	〃 No. 40 —
〃	79	2324.7	〃 No. 42 ♀
〃	79	2324.7	〃 No. 45 ♂
〃	79	2323.2	〃 No. 49 ♀
〃	79	2325.2	〃 No. 69 ♀
〃	79	2325.2	〃 No. 70 ♂
〃	79	2325.2	〃 No. 71 ♀
〃	79	2325.2	〃 No. 76 ♂
	Average 76.8±2.6	Average 2258.0	
28.3°	79	2240.8	1926 No. 6 ♀
〃	79	2240.8	〃 No. 7 —
〃	79	2240.8	〃 No. 8 —
〃	79	2240.8	〃 No. 12 —
〃	79	2240.0	1927 No. 25 ♀
〃	79	2240.0	〃 No. 26 ♂
〃	79	2240.0	〃 No. 27 —
〃	79	2240.0	〃 No. 28 ♂
〃	79	2240.0	〃 No. 29 —
〃	79	2240.0	〃 No. 30 —
〃	79	2240.0	〃 No. 31 —
〃	79	2240.0	〃 No. 32 ♀
〃	79	2240.0	〃 No. 33 ♀
28.5°	79	2252.2	〃 No. 36 ♂
〃	103	2936.0	〃 No. 24 —
	Average 80.6±2.5	Average 2287.4	
26.0°	91	2366.4	1927 No. 1 ♂
〃	91	2366.4	〃 No. 2 ♂
26·1°	103	2690.4	〃 No. 4 ♂
〃	103	2690.4	〃 No. 5 ♂
〃	103	2690.4	〃 No. 6 ♂
〃	103	2690.4	〃 No. 8 ♂
〃	103	2690.4	〃 No. 9 ♂
〃	103	2690.4	〃 No. 10 ♂

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
26.1°	103	2690.4	1927 No. 11 ♂
〃	103	2690.4	〃 No. 12 ♂
〃	103	2690.4	〃 No. 13 ♂
〃	103	2690.4	〃 No. 14 ♂
〃	103	2690.4	〃 No. 15 ♂
〃	103	2690.4	〃 No. 16 ♂
〃	103	2690.4	〃 No. 17 ♂
〃	103	2690.4	〃 No. 18 ♂
〃	103	2690.4	〃 No. 21 ♂
〃	79	2063.2	〃 No. 29 ♂
〃	79	2063.2	〃 No. 30 ♂
26.0°	103	2689.3	〃 No. 62 ♀
26.1°	103	2690.4	〃 No. 3 ♀
〃	103	2690.4	〃 No. 7 ♀
〃	103	2690.4	〃 No. 19 ♀
〃	103	2690.4	〃 No. 20 ♀
〃	103	2690.4	〃 No. 22 ♀
〃	79	2063.2	〃 No. 23 ♀
〃	79	2063.2	〃 No. 26 ♀
〃	79	2063·2	〃 No. 27 ♀
〃	79	2063.2	〃 No. 28 ♀
	Average 97.2±6.7	Average 2537.2	
24.4°	103	2513.6	1926 No. 22 ♂
〃	103	2513.6	〃 No. 24 ♂
24.5°	103	2526.5	〃 No. 37 ♂
〃	103	2526.5	〃 No. 38 ♂
〃	103	2532.7	〃 No. 52 ♂
〃	103	2532.7	〃 No. 53 ♂
〃	96	2357.7	〃 No. 57 ♂
24.6°	103	2539.7	〃 No. 40 ♂
〃	103	2539.7	〃 No. 43 ♀
〃	103	2539.7	〃 No. 47 ♂
〃	103	2539.7	〃 No. 48 ♂
24·4°	103	2523.0	1927 No. 21 ♂
〃	103	2523.0	〃 No. 22 ♂
〃	103	2523.0	〃 No. 23 ♂
〃	103	2523.0	〃 No. 24 ♂
〃	103	2523.0	〃 No. 25 ♂
〃	103	2523.0	〃 No. 26 ♂
〃	103	2523.0	〃 No. 27 ♂
〃	103	2523.0	〃 No. 29 ♂

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
24.4°	96	2351.3	1927 No. 35 ♂
〃	96	2351.3	〃 No. 40 ♂
24.6°	103	2537.2	〃 No. 51 ♂
24.4°	103	2513.6	1926 No. 26 ♀
24.5°	103	2526.5	〃 No. 36 ♀
〃	103	2526.5	〃 No. 39 ♀
〃	96	2357.7	〃 No. 51 ♀
〃	96	2357.7	〃 No. 58 ♀
24.6°	103	2539.7	〃 No. 42 ♀
〃	103	2539.7	〃 No. 44 ♀
〃	103	2539.7	〃 No. 46 ♀
〃	103	2539.7	〃 No. 49 ♀
24.4°	103	2523.0	1927 No. 28 ♀
〃	96	2351.3	〃 No. 30 ♀
〃	96	2351.3	〃 No. 31 ♀
〃	96	2351.3	〃 No. 32 ♀
〃	96	2351.3	〃 No. 34 ♀
24.5°	103	2526.3	〃 No. 36 ♀
〃	103	2526.3	〃 No. 37 ♀
〃	103	2526.3	〃 No. 39 ♀
〃	91	2458.0	〃 No. 43 ♀
24.6°	103	2537.2	〃 No. 44 ♀
〃	103	2537.2	〃 No. 46 ♀
〃	103	2537.2	〃 No. 47 ♀
〃	103	2537.2	〃 No. 48 ♀
〃	103	2537.2	〃 No. 50 ♀
〃	103	2537.2	〃 No. 52 ♀
〃	103	2537.2	〃 No. 53 ♀
〃	103	2537.2	〃 No. 54 ♀
	Average 101.4±3.3	Average 2495.6	
20.2°	151	3052.0	1927 No. 20 ♂
〃	151	3052.0	〃 No. 22 ♂
〃	151	3052.0	〃 No. 23 ♂
〃	144	2912.0	〃 No. 25 ♂
〃	142	2872.0	〃 No. 26 ♂
〃	142	2872.0	〃 No. 28 ♂
〃	142	2872.0	〃 No. 29 ♂
〃	142	2872.0	〃 No. 30 ♂
〃	139	2815.3	〃 No. 35 ♂
〃	151	3055.3	〃 No. 40 ♂
〃	151	3055.3	〃 No. 42 ♂

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
20.2°	151	3055.3	1927 No. 43 ♂
20.3°	199	4057.9	〃 No. 71 ♂
20.5°	151	3097.9	〃 No. 70 ♂
〃	151	3097.9	〃 No. 74 ♂
〃	151	3097.9	〃 No. 76 ♂
〃	151	3097.9	〃 No. 79 ♂
〃	151	3097.9	〃 No. 80 ♂
〃	151	3097.9	〃 No. 82 ♂
〃	151	3097.9	〃 No. 85 ♂
〃	151	3097.9	〃 No. 84 ♂
20.2°	142	2872.0	1927 No. 18 ♀
〃	144	2912.0	〃 No. 21 ♀
〃	144	2912.0	〃 No. 24 ♀
〃	144	2912.0	〃 No. 27 ♀
〃	144	2912.0	〃 No. 31 ♀
〃	142	2872.0	〃 No. 32 ♀
〃	139	2815.3	〃 No. 34 ♀
〃	151	3055.3	〃 No. 37 ♀
〃	151	3055.3	〃 No. 38 ♀
〃	151	3055.3	〃 No. 39 ♀
20.4°	175	3577.9	〃 No. 57 ♀
20.5°	151	3097.9	〃 No. 59 ♀
〃	151	3097.9	〃 No. 68 ♀
〃	151	3097.9	〃 No. 69 ♀
〃	151	3097.9	〃 No. 83 ♀
〃	151	3097.9	〃 No. 86 ♀
20.2°	144	2912.0	〃 No. 17 —
〃	144	2912.0	〃 No. 19 —
〃	151	3055.3	〃 No. 36 —
20.4°	175	3577.9	〃 No. 58 —
20.5°	151	3097.9	〃 No. 61 —
〃	151	3097.9	〃 No. 65 —
〃	151	3097.9	〃 No. 73 —
	Average 150.2±7.8	Average 3058.4	
14.9°	319	4756.8	1927 No. 2 ♂
〃	319	4756.8	〃 No. 3 ♂
〃	307	4576.8	〃 No. 4 ♂
〃	307	4576.8	〃 No. 5 ♂
〃	307	4576.8	〃 No. 6 ♂
〃	319	4756.8	〃 No. 7 ♂
〃	319	4756.8	〃 No. 9 ♂

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
14.9°	307	4576.8	1927 No. 11 ♂
〃	295	4396.8	〃 No. 10 ♀
〃	319	4783.3	〃 No. 16 ♀
〃	319	4783.3	〃 No. 17 ♀
〃	319	4783.3	〃 No. 19 ♀
〃	319	4765.4	〃 No. 24 ♀
〃	319	4765.4	〃 No. 31 ♀
〃	319	4779.5	〃 No. 32 ♀
〃	307	4599.5	〃 No. 33 ♀
〃	307	4599.5	〃 No. 36 ♀
14.9°	295	4396.8	1927 No. 1 —
〃	295	4396.8	〃 No. 8 —
〃	271	4063.3	〃 No. 13 —
〃	319	4783.3	〃 No. 14 —
〃	295	4406.3	〃 No. 27 —
〃	319	4765.4	〃 No. 29 —
〃	307	4599.5	〃 No. 34 —
〃	343	5139.5	〃 No. 35 ♂
	Average 310.8±9.7	Average 4645.6	

Growing Period.

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
33.0°	264	8712.0	1925(A) No. 30
〃	264	8712.0	1925(B) No. 2
〃	240	7920.0	〃 No. 4
〃	240	7920.0	〃 No. 8
〃	240	7920.0	〃 No. 9
〃	264	8712.0	〃 No. 10
〃	240	7920.0	〃 No. 13
〃	264	8712.0	〃 No. 14
〃	312	10296.0	〃 No. 15
〃	264	8712.0	〃 No. 16
〃	240	7920.0	〃 No. 21
〃	240	7920.0	〃 No. 22
〃	216	7128.0	〃 No. 23
〃	312	10296.0	〃 No. 24
〃	288	9504.0	〃 No. 31
	Average 259.2±17.9	Average 8553.6	
32.8°	312	10245.3	1925(B) No. 6
〃	264	8661.3	〃 No. 12
〃	264	8675.2	1927 No. 17
〃	240	7883.2	〃 No. 18
32.7°	144	4715.2	〃 No. 10
〃	168	5507.2	〃 No. 12
〃	168	5507.2	〃 No. 13
〃	168	5507.2	〃 No. 15
32.7°	144	4715.2	1927 No. 20
〃	168	5507.2	〃 No. 21
〃	168	5507.2	〃 No. 22
〃	192	6289.2	〃 No. 29
32.6°	264	8623.9	〃 No. 25
〃	264	8623.9	〃 No. 31
	Average 209.1±31.7	Average 6854.8	
32.1°	264	8478.0	1925(A) No. 6
〃	264	8478.0	〃 No. 11
〃	240	7722.0	〃 No. 21
〃	240	7722.0	〃 No. 24
〃	240	7722.0	〃 No. 25
32.0°	216	6930.0	〃 No. 23
〃	216	6930.0	〃 No. 26
〃	216	6930.0	〃 No. 19
	Average 237±12.6	Average 7614.0	
31.7°	240	7614.0	1925(A) No. 1
〃	192	6102.0	〃 No. 7
〃	192	6102.0	〃 No. 8
〃	192	6102.0	〃 No. 12
31.5°	264	8316.0	1925 No. 14
〃	216	6804.0	〃 No. 20

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
31.5°	288	9072.0	1925 No. 21
〃	216	6804.0	〃 No. 22
〃	240	7560.0	〃 No. 23
〃	216	6804.0	〃 No. 27
〃	216	6804.0	〃 No. 28
〃	240	7560.0	〃 No. 29
〃	264	8316.0	〃 No. 30
	Average 228.9±19.8	Average 7150.7	
30.0°	192	5760.0	1926 No. 4 ♀
〃	192	5760.0	〃 No. 25 ♀
〃	240	7400.0	〃 No. 26 —
〃	168	5040.0	〃 No. 27 —
〃	216	6480.0	〃 No. 45 ♂
〃	252	7560.0	〃 No. 46 ♀
〃	192	5760.0	〃 No. 61 ♀
〃	192	5760.0	〃 No. 62 ♂
〃	185	5550.0	〃 No. 69 ♀
〃	233	6990.0	〃 No. 70 ♂
〃	216	6480.0	〃 No. 71 ♀
〃	185	5550.0	〃 No. 72 —
〃	209	6270.0	〃 No. 74 —
〃	209	6270.0	〃 No. 76 ♂
〃	209	6270.0	〃 No. 77 —
29.9°	240	7181.8	〃 No. 36 —
〃	240	7181.8	〃 No. 37 ♂
〃	264	7907.2	〃 No. 49 ♀
〃	216	6467.2	〃 No. 52 ♀
〃	192	5747.2	〃 No. 56 —
〃	240	7187.2	〃 No. 57 —
29.8°	199	5933.8	〃 No. 18 ♀
〃	216	6455.5	〃 No. 19 —
〃	144	4301.8	〃 No. 30 ♂
〃	168	5021.8	〃 No. 31 ♂
	Average 208.3±21.5	Average 6251.4	
29.0°	96	2790.8	1927 No. 1 —
〃	96	2790.8	〃 No. 2 ♂
〃	192	5583.0	〃 No. 28 ♂
〃	192	5583.0	〃 No. 26 ♂
〃	192	5583.0	〃 No. 32 ♀

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
29.2°	120	3510.8	1927 No. 3 ♀
〃	192	5621.6	〃 No. 10 ♂
〃	192	5621.6	〃 No. 20 ♀
〃	240	7023.0	〃 No. 25 ♀
〃	240	7023.0	〃 No. 29 —
〃	240	7023.0	〃 No. 31 —
〃	240	7023.0	〃 No. 33 ♀
29.3°	168	4925.6	〃 No. 4 ♀
〃	168	4925.6	〃 No. 5 ♂
〃	168	4925.6	〃 No. 6 ♀
〃	168	4925.6	〃 No. 7 —
〃	144	4229.6	〃 No. 8 ♀
〃	168	4925.6	〃 No. 11 —
〃	168	4925.6	〃 No. 14 ♂
〃	168	4925.6	〃 No. 15 ♂
〃	168	4925.6	〃 No. 18 ♀
〃	144	4229.6	〃 No. 21 ♀
〃	168	4925.6	〃 No. 22 ♂
〃	144	4229.6	〃 No. 23 ♀
	Average 174±26.5	Average 5091.4	
27.0°	228	6156.0	1927 No. 1 ♂
〃	252	6804.0	〃 No. 2 ♂
〃	192	5184.0	〃 No. 4 ♂
〃	192	5184.0	〃 No. 5 ♂
〃	216	5832.0	〃 No. 6 ♂
〃	240	6480.0	〃 No. 8 ♂
〃	192	5184.0	〃 No. 9 ♂
〃	264	7128.0	〃 No. 10 ♂
〃	240	6480.0	〃 No. 11 ♂
〃	264	7128.0	〃 No. 12 ♂
〃	216	5832.0	〃 No. 13 ♂
〃	216	5832.0	〃 No. 14 ♂
〃	192	5184.0	〃 No. 15 ♂
〃	216	5832.0	〃 No. 16 ♂
〃	216	5832.0	〃 No. 17 ♂
〃	192	5184.0	〃 No. 18 ♂
〃	216	5832.0	〃 No. 21 ♂
27.1°	192	5220.0	1925 No. 1 ♂
27.0°	168	4536.0	1927 No. 3 ♀
〃	216	5832.0	〃 No. 7 ♀
〃	240	6480.0	〃 No. 19 ♀

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
27.0°	216	5832.0	1927 No. 20 ♀
〃	216	5832.0	〃 No. 22 ♀
27.1°	216	5868·0	〃 No. 59 ♀
〃	240	6516.0	〃 No. 60 ♀
〃	240	6516.0	〃 No. 61 ♀
〃	192	5220.0	1925 No. 2 ♀
〃	192	5220.0	〃 No. 4 ♀
	Average 216.8±16.8	Average 5873.5	
25.0°	216	5400.0	1925 No. 5 ♂
〃	216	5400.0	〃 No. 6 ♂
〃	216	5400.0	〃 No. 8 ♂
〃	216	5400.0	〃 No. 13 ♂
〃	192	4800.0	〃 No. 15 ♂
〃	288	7201.5	1926 No. 5 ♂
〃	240	6000.0	〃 No. 22 ♂
〃	240	6000.0	〃 No. 24 ♂
〃	264	6600.0	〃 No. 37 ♂
〃	264	6600.0	〃 No. 38 ♂
〃	264	6600.0	〃 No. 40 ♂
〃	264	6600.0	〃 No. 43 ♂
〃	216	5400.0	〃 No. 47 ♂
〃	264	6600.0	〃 No. 48 ♂
〃	264	6600.0	〃 No. 52 ♂
〃	288	7100.0	〃 No. 53 ♂
〃	247	6175.0	〃 No. 57 ♂
〃	240	6000.0	1927 No. 21 ♂
〃	240	6000.0	〃 No. 22 ♂
〃	240	6000.0	〃 No. 23 ♂
〃	216	5400.0	〃 No. 24 ♂
〃	240	6000.0	〃 No. 25 ♂
〃	264	6600.0	〃 No. 26 ♂
〃	264	6600.0	〃 No. 27 ♂
〃	264	6600.0	〃 No. 29 ♂
〃	271	6775.0	〃 No. 35 ♂
〃	247	6175.0	〃 No. 40 ♂
〃	288	7200.0	〃 No. 51 ♂
〃	216	5400.0	〃 No. 59 ♂
〃	192	4800.0	1925 No. 10 ♀
〃	216	5400.0	〃 No. 14 ♀
〃	264	6601.5	1926 No. 1 ♀
〃	264	6601.5	〃 No. 8 ♀

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
25.0°	252	6300.0	1926 No. 21 ♀
〃	264	6600.0	〃 No. 26 ♀
〃	264	6600.0	〃 No. 36 ♀
〃	240	6000.0	〃 No. 39 ♀
〃	240	6000.0	〃 No. 42 ♀
〃	240	6000.0	〃 No. 44 ♀
〃	271	6775.0	〃 No. 58 ♀
〃	288	7200.0	〃 No. 61 ♀
〃	264	6600.0	1927 No. 28 ♀
〃	247	6175.0	〃 No. 30 ♀
〃	271	6775.0	〃 No. 31 ♀
〃	271	6775.0	〃 No. 32 ♀
〃	271	6775.0	〃 No. 34 ♀
〃	264	6600.0	〃 No. 36 ♀
〃	264	6600.0	〃 No. 39 ♀
〃	252	6300.0	〃 No. 43 ♀
〃	240	6000.0	〃 No. 44 ♀
〃	240	6000.0	〃 No. 46 ♀
〃	240	6000.0	〃 No. 48 ♀
〃	264	6600.0	〃 No. 50 ♀
〃	240	6000.0	〃 No. 52 ♀
〃	240	6000.0	〃 No. 54 ♀
〃	216	5400.0	〃 No. 58 ♀
〃	261	5400.0	〃 No. 62 ♀
〃	264	6600.0	1927 No. 63 ♀
〃	216	5400.0	〃 No. 56 ♀
	Average 247.8±17.1	Average 6194.9	
20.0°	336	6720.0	1927 No. 6 ♂
〃	408	8160.0	〃 No. 7 ♂
〃	384	7680.0	〃 No. 13 ♂
〃	408	8160.0	〃 No. 14 ♂
〃	384	7680.0	〃 No. 22 ♂
〃	336	6720.0	〃 No. 23 ♂
〃	367	7340.0	〃 No. 25 ♂
〃	441	8820.0	〃 No. 26 ♂
〃	345	6900.0	〃 No. 28 ♂
〃	417	8340.0	〃 No. 29 ♂
〃	369	7380.0	〃 No. 30 ♂
〃	367	7340.0	〃 No. 33 ♂
〃	360	7200.0	〃 No. 40 ♂
〃	360	7200.0	〃 No. 42 ♂

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
20.0°	336	6720.0	1927 No. 43 ♂
〃	408	8160.0	〃 No. 9 ♀
〃	384	7680.0	〃 No. 11 ♀
〃	369	7380.0	〃 No. 18 ♀
〃	343	6860.0	〃 No. 21 ♀
〃	343	6860.0	〃 No. 24 ♀
〃	343	6860.0	〃 No. 27 ♀
〃	367	7340.0	〃 No. 31 ♀
〃	348	6960.0	〃 No. 34 ♀
〃	360	7200.0	〃 No. 37 ♀
〃	417	8340.0	〃 No. 32 ♀
20.0°	336	6720.0	〃 No. 38 ♀
〃	336	6720.0	〃 No. 39 ♀
	Average 369.3±20.2	Average 7386.6	
17.0°	456	7752	1927 No. 10
〃	504	8568	〃 No. 19
16.9°	480	8112	1927(B) No. 35
〃	540	9132	〃 No. 36
	Average 495±20.9	Average 8641	

Cocoon Period.

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
33.0°	228	7524	1925(A) No. 24 ♂
〃	156	5148	〃 No. 28 ♀
〃	192	6336	1926 No. 14 ♀
〃	204	6732	〃 No. 16 ♀
〃	204	6732	1925(B) No. 4 ♂
〃	204	6732	〃 No. 7 ♂
〃	204	6732	〃 No. 10 ♀
〃	180	5940	〃 No. 11 ♂
〃	180	5940	〃 No. 12 ♀
〃	204	6732	〃 No. 14 ♀
〃	204	6732	〃 No. 19 ♂
〃	204	6732	〃 No. 21 ♀
〃	228	7524	〃 No. 23 ♂
〃	204	6732	〃 No. 24 ♀
〃	228	7524	〃 No. 26 ♂
〃	204	6732	〃 No. 30 ♂
〃	228	7524	〃 No. 33 ♂
〃	180	5940	1927 No. 10 ♀
〃	228	7524	〃 No. 13 ♀
〃	228	7524	〃 No. 21 ♂
〃	132	4356	〃 No. 24 ♀
〃	228	7524	〃 No. 34 ♀
〃	204	6732	〃 No. 35 ♀
	Average 202.4±16.4	Ave rage 6680.3	
31.5°	204	6426	1925 No. 14
〃	180	5670	〃 No. 20
〃	228	7182	〃 No. 21
〃	228	7182	〃 No. 22
〃	228	7182	〃 No. 23
〃	228	7182	〃 No. 27
〃	204	6426	〃 No. 28
〃	252	7938	〃 No. 29
〃	228	7182	〃 No. 30
	Average 220±13.2	Average 6930	
30.0°	132	3960	1925 No. 3 ♂
〃	180	5400	〃 No. 5 ♂
〃	204	6120	〃 No. 30 ♂
〃	180	5400	〃 No. 31 ♂
〃	132	3960	〃 No. 37 ♂
〃	156	4680	〃 No. 45 ♂
〃	187	5610	〃 No. 62 ♂
〃	211	6330	〃 No. 70 ♂
〃	187	5610	〃 No. 76 ♂
〃	156	4680	1927 No. 26 ♂
〃	180	5400	〃 No. 28 ♂
〃	156	4672.2	1926 No. 46 ♀
〃	180	5400	〃 No. 49 ♀

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
30.0°	156	4680	1926 No. 52 ♀
〃	163	4890	〃 No. 61 ♀
〃	187	5610	〃 No. 69 ♀
〃	180	5400	〃 No. 71 ♀
〃	180	5400	1927 No. 25 ♀
〃	180	5400	〃 No. 32 ♀
〃	156	4680	〃 No. 33 ♀
〃	180	5400	〃 No. 34 ♀
	Average 172.5±13.5	Average 5175.3	
29.0°	228	6612	1927 No. 5 ♂
〃	204	5916	〃 No. 10 ♂
〃	276	8004	〃 No. 13 ♂
〃	228	6612	〃 No. 14 ♂
〃	228	6612	〃 No. 15 ♂
〃	180	5220	〃 No. 16 ♂
〃	228	6612	〃 No. 22 ♂
〃	228	6612	〃 No. 4 ♀
〃	228	6612	〃 No. 6 ♀
〃	180	5220	〃 No. 8 ♀
〃	228	6612	〃 No. 18 ♀
〃	228	6612	〃 No. 20 ♀
〃	156	4524	〃 No. 21 ♀
〃	180	5220	〃 No. 23 ♀
	Average 214.2±20.4	Average 6214.2	
27.5°	156	4290	1925(A) No. 3 ♂
〃	180	4950	〃 No. 4 ♂
〃	180	4950	〃 No. 9 ♂
〃	204	5610	〃 No. 14 ♂
〃	180	4950	〃 No. 15 ♂
〃	204	5610	〃 No. 17 ♂
〃	204	5610	〃 No. 18 ♂
〃	180	4950	〃 No. 22 ♂
〃	204	5610	〃 No. 30 ♂
〃	204	5610	1925(B) No. 1 ♂
〃	180	4950	〃 No. 8 ♂
〃	204	5610	〃 No. 16 ♂
〃	204	5610	〃 No. 20 ♂
〃	204	5610	〃 No. 23 ♂
〃	180	4950	〃 No. 25 ♂

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
27.5°	180	4950	1925(B) No. 28 ♂
〃	204	5610	1925(A) No. 2 ♀
〃	180	4950	〃 No. 6 ♀
〃	180	4950	〃 No. 8 ♀
〃	204	5610	〃 No. 10 ♀
〃	180	4950	〃 No. 11 ♀
〃	204	5610	〃 No. 12 ♀
〃	204	5610	〃 No. 13 ♀
〃	204	5610	〃 No. 19 ♀
〃	204	5610	〃 No. 20 ♀
〃	204	5610	〃 No. 26 ♀
〃	204	5610	〃 No. 29 ♀
〃	204	5610	1925(B) No. 2 ♀
〃	204	5610	〃 No. 4 ♀
〃	132	3630	〃 No. 17 ♀
〃	204	5610	〃 No. 18 ♀
〃	204	5610	〃 No. 19 ♀
〃	204	5610	〃 No. 22 ♀
〃	204	5610	〃 No. 24 ♀
〃	180	4950	〃 No. 26 ♀
〃	204	5610	〃 No. 29 ♀
	Average 193.3±11.3	Average 5316.6	
26.8°	228	6132	1927 No. 10 ♂
〃	180	4836	〃 No. 15 ♂
〃	180	4836	〃 No. 16 ♂
〃	180	4836	〃 No. 21 ♂
〃	228	6116	〃 No. 58 ♂
26.9°	252	6780	〃 No. 11 ♂
27.0°	204	5484	〃 No. 1 ♂
〃	204	5484	〃 No. 2 ♂
〃	204	5484	〃 No. 4 ♂
〃	204	5484	〃 No. 5 ♂
〃	204	5484	〃 No. 6 ♂
〃	204	5484	〃 No. 8 ♂
〃	204	5484	〃 No. 9 ♂
〃	204	5484	〃 No. 12 ♂
〃	204	5484	〃 No. 13 ♂
〃	204	5484	〃 No. 17 ♂
〃	204	5484	〃 No. 18 ♂
〃	204	5508	〃 No. 29 ♂
〃	228	6156	〃 No. 56 ♂

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
27.0°	180	4860	1927 No. 65 ♂
26.8°	228	6132	〃 No. 20 ♀
〃	228	6132	〃 No. 22 ♀
〃	204	5468	〃 No. 60 ♀
〃	204	5468	〃 No. 61 ♀
〃	180	4846	〃 No. 3 ♀
〃	204	5484	〃 No. 7 ♀
〃	204	5484	〃 No. 19 ♀
〃	228	6156	〃 No. 23 ♀
〃	204	5508	〃 No. 26 ♀
〃	204	5508	〃 No. 54 ♀
〃	204	5508	〃 No. 62 ♀
〃	180	4860	〃 No. 63 ♀
	Average 205.5±11.4	Average 5529.3	
24.9°	252	6284.5	1926 No. 5 ♂
〃	228	5679.7	〃 No. 22 ♂
〃	228	5679.7	〃 No. 24 ♂
〃	228	5679.7	〃 No. 37 ♂
〃	300	7479.7	〃 No. 38 ♂
〃	276	6879.7	〃 No. 40 ♂
〃	276	6879.7	〃 No. 43 ♂
〃	252	6279.7	〃 No. 47 ♂
〃	252	6279.7	〃 No. 48 ♂
25.0°	276	6900.0	1927 No. 21 ♂
〃	252	6300.0	〃 No. 22 ♂
〃	228	5700.0	〃 No. 23 ♂
〃	252	6300.0	〃 No. 24 ♂
〃	204	5100.0	〃 No. 25 ♂
〃	180	4500.0	〃 No. 26 ♂
〃	204	5100.0	〃 No. 27 ♂
〃	156	3900.0	〃 No. 29 ♂
〃	228	5700.0	〃 No. 35 ♂
〃	252	6300.0	〃 No. 40 ♂
〃	252	6300.0	〃 No. 51 ♂
24.9°	252	6284.5	1926 No. 1 ♀
〃	252	6279.7	〃 No. 26 ♀
〃	300	7479.7	〃 No. 36 ♀
〃	252	6279.7	〃 No. 39 ♀
〃	228	5679.7	〃 No. 42 ♀
〃	276	6879.7	〃 No. 44 ♀
〃	228	5679.7	〃 No. 46 ♀

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
24.9°	276	6879.7	1926 No. 49 ♀
25.0°	204	5100.0	〃 No. 8 ♀
〃	228	5700.0	1927 No. 28 ♀
〃	228	5700.0	〃 No. 30 ♀
〃	228	5700.0	〃 No. 31 ♀
〃	252	6300.0	〃 No. 32 ♀
〃	228	5700.0	〃 No. 34 ♀
〃	252	6300.0	〃 No. 36 ♀
〃	228	5700.0	〃 No. 39 ♀
〃	228	5700.0	〃 No. 43 ♀
〃	228	5700.0	〃 No. 44 ♀
〃	228	5700.0	〃 No. 46 ♀
〃	252	6300.0	〃 No. 48 ♀
〃	276	6900.0	〃 No. 50 ♀
〃	228	5700.0	〃 No. 52 ♀
〃	252	6300.0	〃 No. 54 ♀
	Average 241.3±19.4	Average 6027.0	
20.0°	396	7920	1927(A) No. 4 ♂
〃	420	8400	〃 No. 6 ♂
〃	348	6960	〃 No. 13 ♂
〃	300	6000	〃 No. 22 ♂
〃	324	6480	〃 No. 23 ♂
〃	324	6480	〃 No. 25 ♂
〃	300	6000	〃 No. 26 ♂
〃	324	6480	〃 No. 28 ♂
〃	372	7440	〃 No. 29 ♂
〃	300	6000	〃 No. 30 ♂
〃	396	7920	〃 No. 33 ♂
〃	300	6000	〃 No. 40 ♂
〃	300	6000	〃 No. 42 ♂
〃	348	6960	〃 No. 43 ♂
〃	372	7440	1927(B) No. 2 ♂
〃	348	6960	〃 No. 3 ♂
〃	324	6480	〃 No. 4 ♂
〃	396	7920	〃 No. 5 ♂
〃	396	7920	〃 No. 6 ♂
〃	396	7920	〃 No. 7 ♂
〃	372	7440	〃 No. 9 ♂
〃	372	7440	〃 No. 11 ♂
〃	396	7920	〃 No. 22 ♂
〃	348	6960	〃 No. 23 ♂

Temperature C.	Duration in Hours.	Accumulated Temperatures above 0° C.	Remarks.
20·0°	348	6960	1927(B) No. 35 ♂
〃	396	7920	1927(A) No. 9 ♀
〃	348	6960	〃 No. 11 ♀
〃	348	6960	〃 No. 14 ♀
〃	300	6000	〃 No. 18 ♀
〃	348	6960	〃 No. 21 ♀
〃	348	6960	〃 No. 24 ♀
〃	348	6960	〃 No. 27 ♀
〃	348	6960	〃 No. 31 ♀
〃	300	6000	〃 No. 32 ♀
〃	300	6000	〃 No. 34 ♀
〃	324	6480	〃 No. 37 ♀
〃	324	6480	〃 No. 38 ♀
〃	324	6480	〃 No. 39 ♀
〃	372	7440	1927(B) No. 16 ♀
20.0°	420	8400	1927(B) No. 19 ♀
〃	372	7440	〃 No. 24 ♀
〃	348	6960	〃 No. 31 ♀
〃	396	7920	〃 No. 33 ♀
〃	348	6960	〃 No. 36 ♀
	Average 350.7±23.9	Average 7014.5	
17.1°	540	9288.7	1927 No. 4
17.2°	492	8472.7	〃 No. 5
17.3°	492	8544.7	〃 No. 10
17.4°	540	9432.7	〃 No. 7
	Average 516±16.2	Average 8934.7	