Band II. Heft 3.

Berichte

des

Ōhara Instituts für landwirtschaftliche Forschungen

1923

Second Notes on the Oriental Peach Moth,

Laspeyresia molesta Busck.

By

Chūkichi Harukawa, *Nōgakushi.*

[January 30, 1923]

I. Introduction.

In 1917 the writer reported the results of his studies on the Oriental peach moth, *Laspeyresia molesta* Busk, which he had obtained until the beginning of that year.[1]

At the end of 1919 the writer submitted to the Bureau of Agriculture a report[2] of his studies on the same insect, which contained almost all the results that he had obtained by that time.

The present notes consist chiefly of those results which the writer has obtained since the appearance of his first report, most of which were contained in the report which was submitted to the Bureau of Agriculture. Since 1917 several authors have published results of their studies and observations on the Oriental Peach Moth and some of their data will be quoted in the present paper.

1) Berichte d. Ohara Instituts f. Landw. Forschungen, Bd. I, Heft. 2.

2) Byokin Gaichu Iho, No. 7, (Bulletin Regarding Injurious Insects and Plant diseases.), Bur. Agricult., Japan.

II. Distribution in Japan.

The Oriental peach moth seems to be widely distributed in Japan. There are however still many prefectures in which this insect has not yet been found, though at least one or two of the four species of fruit trees, the peach, pear, cherry and the apple are grown there.

In some localities the introduction of this insect seems to have occurred recently. The known habitats of this species are the prefectures of Kumamoto, Miyasaki, Nagasaki, Fukuoka, Saga, Kagoshima, Hiroshima, Shimane, Tottori, Okayama, Ehime, Kōchi, Hyogo, Osaka, Wakayama, Kyoto, Yamanashi, Shiga, Gifu, Nagano, Nara, Shizuoka, Kanagawa, Tokyo, Chiba, Gumma, Ibaraki, Miyagi, Fukushima, Iwate, Aomori, Yamagata, Akita, Niigata, Ishikawa, Toyama, and Korea. The Oriental peach moth was found several years ago in Aomori, Morioka and in Fukushima, where it does not yet appear to be abundant. In Shizuoka the damage done by this insect has been quite large during the past five or six years, yet this insect does not seem to be a very old pest there; while in this prefecture, there are many localities growing the pear where the Oriental peach moth is not yet found.

Again, in Okayama the injury by this moth to pears has been occurring for more than fifteen years. However, in some orchards which are far from large towns or cities, this insect has not yet been found.

The writer has been informed that the Oriental peach moth does not occur in the mountainous regions of Miyasaki Prefecture, though it does inhabit in some parts of the lowlands.

The insect has not yet been reported from Hokkaido, Roochoo and Formosa.

III. Life-History and Habits.

1. Life-history.

Appearance of the adults in the spring.

As is well known, the Oriental peach moth overwinters in the larval stage, transforming in the spring to the pupal and adult stages. To determine the dates of emergence the writer let the larvae make their cocoons in small bundles of the wheat or barley and kept them in the insectary during the winter. At the beginning of April these bundles were carried out of the room to the south side of the insectary during the day. The appearance of the imago in our insectary generally begins slightly later than in the field.

The treatment of the overwintered insects just stated above was done in order to avoid this delay in emergence and to simulate the condition in the

field as far as possible.

According to the results of these experiments in three years (from 1917 to 1919), the emergence began between April 4th and May 2nd and ended between May 14th and 20th. The period of maximum emergence was the 12th or 13th of May in 1917, May 6th or 7th in 1918 and in 1919 from the 20th to the 30th of April.

Now, in the field the writer saw the adult for the first time on April 18th in 1918 and on April 5th in 1919.

From these observations it may be said that the maximum emergence of the adult in the field occurs near the end of April.

The time of the appearance of the adult will be different according to different climatic conditions. Thus, in Aomori, the most northern prefecture in the Main Land of Japan, the appearance of the adult seems to occur near the middle of June; in the vicinity of Tokyo it begins on about the sixth or the seventh of May; while in Korea it occurs between the 20th and 31st of May. It is very difficult to ascertain when the emergence of the adult ends in the field. However, we can infer this approximately by the appearance of the peach shoot into which the newly hatched larva has just bored.

According to the field observations the appearance of the newly infested shoots stops generally by the 20th or 25th of May. As the incubation period of the egg is about 10 days we can probably say that the emergence of the adult ends by about the 10th or 15th of May in an orchard in the vicinity of Kurashiki.

Number of broods.

In his first report the writer stated that the Oriental peach moth occurs five times a year in Kurashiki. In 1918, 1919 and 1920 the writer repeated the rearing experiments. For the sake of brevity, just the time of the beginning of the emergence of the adult is shown in table I.

Table I.

Rearing Experiment, (Time of Emergence of Adult)

Year	The last gener. of preceding year.	First Gener.	Second Gener.	Third Gener.	Fourth Gener.	Fifth Gener.
1918	April 27	June 10	July 7	Aug. 3	Sept. 5	Overwinter
1919	„ 20	„ 5	„ 10	„ 8	„ 6	„
1920 No. 1	—	„ 6	„ 5	July 30	Aug. 22	„
1920 No. 2	—	—	„ 9	Aug. 2	„ 28	„
1920 No. 3	—	June 28	„ 24	„ 24?	Overwinter	

In 1920 three series of rearing were conducted. Series No. 1 in 1920 includes those rearing experiments in which the rearing was started in the spring with infested shoots of the peach collected in the field. The collection was made several times, beginning on May 6th. The aduld of the first generation of this series began to emerge on June 6th and the emergence continued till June 27th. With the adult of this series which emerged on June 12th, another series of rearing was begun. This is the Series No. 2, which began therefore from the second generation.

Another series of rearing was begun with a pair of adults which emerged on May 27th from the overwintered larvae of the last generation in the preceding year. This is named Series No. 3.

Now, under the out-of-door conditions in Kurashiki the emergence of the adult of the overwintered brood generally ends by the middle of May. The series No. 3 may, therefore, be considered as the exceptionally late individuals.

As is shown in the table, in 1918 and 1919 there were five generations and in the first two series in 1920 also five generations were completed; while in the third series of 1920 there were only four generations. The results of these rearing experiments (excepting the series No. 3 of 1920) are almost in agreement with the observation in the field with regard to the time of emergence of the adult of the first generation.

The writer therefore concludes that the majority of the Oriental peach moths produce five generations in Kurashiki under out-of-door conditions; and that some individuals may produce only four broods. As the duration of a life-cycle is affected by climatic conditions, it is possible that there are three or four generations of the Oriental peach moth in some parts of Japan. Thus, it has been reported that there are only three generations in Korea[1] and four generations in Gumma,[2] Niigata[3] and Shimane.[4]

According to the observation in the field, there is a short interval between the time of the occurrence of the first and the second generation. During that time no newly infested shoots can be seen. However, as the appearance of the adult in the spring covers a long period, there occurs the overlapping of the two consecutive generations after the hatching of the second generation begins; so that we almost always see the newly infested young shoots in the orchard. Therefore, the injuries done by different broods can not be distinguished in the field.

The larva can be found until about the beginning of November. For example, the writer saw in the band experiment a few larvae that were making

---

1) MURAMATSU, S. Byo Chu Gai Zasshi, (Jour. Plant Protection), Vol. VI, No. 12, 1919.
2) Ann. Rept. Agricult. Exp. Stat. Gumma Pref., Japan, for 1916.
3) Ann. Rept. Agricult. Exp. Stat. Niigata Pref., for 1916.
4) NODZU, R. Byo Chu Gai Zasshi, Vol. IV, No. 2, 3, 1917.

cocoons as late as November 9th in 1918 and October 23rd in 1919. Larvae are seen boring in the pear till about the beginning of November.

Adults emerge until about the 20th of September. For instance the writer saw adults till September 25th in 1916, September 15th in 1918 and September 16th in 1919.

The larvae which make cocoons about the middle of September do not transform into adults in that year, but overwinter in their cocoons.

Time required for the completion of one life-cycle.

The duration from the oviposition to the appearance of the adult insect varies considerably under different climatic conditions.

The figures below will show the approximate ranges of the duration from the results of rearing experiments.

The first generation	.....	from 35 to 45	days
The second „	.....	„ 24 „ 37	„
The third „	.....	„ 20 „ 31	„
The fourth „	.....	„ 20 „ 25	„
The fifth „	(Oviposition to maturity of larva)	„ 16 „ 25	„

It is seen that the time required for the first generation is markedly longer than for the other generations. This is chiefly due to the lower temperature in the spring and at the beginning of summer.

Results[1] obtained in other parts of Japan are cited below to compare with the data obtained by the writer.

Niigata	1st generation	.....	34 days
	2nd „	..... 28 to 33	„
	3rd „	..... 26 to 28	„
	4th „	(From oviposition to maturity of larva) 22 to 25	„
Korea	1st „	 39	„
	2nd „	 38	„
	3rd „	(From oviposition to maturity of larva) 31	„

2. Habits of Adult.

Oviposition.

The writer stated in his first report that oviposition and mating of the adult insect take place in the evening. Later, it has been observed that the female sometimes begins to oviposit at about three o'clock in the afternoon when it is cloudy and the oviposition may occur at night also.

In a peach orchard, almost fully expanded leaves are preferred for laying eggs, though the adult sometimes lays its eggs on leaves which are not yet fully expanded and are situated almost at the tip of a shoot, especially when there are few growing shoots on the peach tree, as, for example in late

1) Loc. cit.

summer or in autumn. It is generally the fifth or sixth leaf from the tip of a shoot, on which empty egg shells are found after the hatching of larvae, as this has already been pointed out by GARMAN.[1)]

The writer has not yet seen eggs laid on the peach fruit. MURAMATSU stated, however, that he had observed such a case.

In a pear orchard, the manner of oviposition is somewhat different. Namely, when the tree is bearing fruits, the adult sometimes lays its eggs on a young, green fruit. When the pear fruit is ripe, eggs are laid on the side of the fruit, the stem, the cavity of the stem and the calyx-cavity, especially the last two sites are preferred. When the fruit is covered with a paper bag, eggs are laid on the bag, on a branch near the fruit or on the leaves that are close by the fruit. While, if the pear tree has no fruits, the adult insect prefers the leaf, but sometimes it oviposits on the petiole of a leaf, or on a green shoot.

When the adult is confined in a very small breeding cage, the manner of oviposition becomes somewhat irregular. For this reason the results of observation in 1916 did not show the normal oviposition habit of the adult.

In the first half of the season of 1917, the writer studied the oviposition habits by confining a few females in a large cage, each side of which measured about five feet.

This cage was placed outside in such a way as to cover two small fruit trees, one a peach and the other a pear, which were planted in the experimental garden. Even in this cage the moth did not show the strictly normal habit. In the latter half of that season as well as in 1918 and 1919, another method was adopted. Namely, a large mosquito-net about fifteen feet long, nine feet wide and seven feet high was used. Ten or twelve trees about five feet high, half of which were the peach and the rest the pear, were planted side by side in the experimental garden. They were covered with the mosquito-net just mentioned and into which many pairs of the adults were confined. The results of the experiments which were conducted in 1917 to see the site for oviposition are shown in table II.

Some Japanese writers on the Oriental peach moth state that the adults of the overwintered generation and those of the first never lay eggs on the pear. The results of the writer's experiments show that this is not always the case. It is apparent from the table II that the adults of the overwintered generation and those of the first and the second generations lay most of their eggs on leaves of both the peach and the pear. In a peach orchard many young shoots are attacked by the larvae of the Oriental peach moth and sometimes young, green peach fruits are also attacked in the spring and early summer. While, in a pear orchard near a peach orchard, the pear shoots attacked by the larvae are rarely seen in the spring and in the early sum-

1) GARMAN, P. Maryland Agr. Exp. Stat. Bul. 209, 1917.

mer according to the writer's observation in the vicinity of Kurashiki, though moths are not rare in the pear orchard.

Table II.

Sites for Oviposition.

A. In the first half of 1917.

Kinds of tree	Generation	Leaf		Shoot	Fruit	Remark
		Under side	Upper side			
Peach	Last gener. preced. year	42	0	0	0	Peach trees bearing fruits
	First gen.	37	1	0	0	
	Second gen.	122	11	2	0	
	Total numb. eggs	201	12	2	0	

Kinds of tree	Generation	Leaf		Petiole	Shoot	Fruit
		Under side	Upper side			
Pear	Last gener. preced. year	53	3	0	4	0
	First gener.	27	3	5	1	1
	Second gener.	85	1	0	2	7
	Total numb. eggs	165	7	5	7	8

B. In the second half of 1917.

Kinds of tree	Site of oviposit.	Third gener.	Fourth gener.	Total number of eggs	Remarks
Peach	Leaf	454	548	1002	Peach trees had no fruit
	Other parts	11	0	11	
Pear	Fruit	18	326	344	
	Other parts	113	1443	1556	

However, in certain localities where pear-trees are grown, it is known that the adult lays its eggs on the pear-tree in the spring and in the early summer, and larvae are seen attacking the young, green pear fruits.

Why does such a difference in the habit of oviposition appear? To answer this question the writer conducted experiments to see which of the peach and pear the Oriental peach moth prefers for oviposition. A part of these

experiments which was conducted in 1917 has already been shown in a somewhat modified form in table II. The method of the experiments has also been described above. All the leaves, shoots and the fruits were examined every other day or sometimes on every three days, the number of eggs laid were recorded; and at the same time all the eggs were scraped off to avoid counting the same egg twice. The results obtained are shown in table III.

Table III.

Choice of Plants for Oviposition. (1)

Date of Oviposition	Peach	Pear			Remarks
		Fruit	Other parts	Total	
In 1917					
			Overwintering Generation		
May 15—20	2	0	3	3	All the pear trees were Japanese sand pear.
„ 21—25	40	0	15	15	
			First Generation		
June 15—20	0	0	0	0	Cages used were of the size of 5×5×5 in feet.
„ 21—25	26	1	26	27	
„ 26—28	12	0	10	10	
			Second Generation		
July 10—15	27	0	11	11	
„ 16—20	99	6	62	68	
„ 21—25	52	1	18	19	
			Third Generation		
Aug. 7—10	228	10	44	54	In the third and fourth generation the mosquito nets were used and a part of the pear-trees were Japanese sand pear.
„ 11—15	187	4	37	41	
„ 16—20	40	1	20	21	
„ 21—26	8	3	13	16	
			Fourth Generation		
Aug. 29—31	22	49	55	104	All the pear fruits picked off.
Sept. 1— 5	157	150	472	622	
„ 6—10	234	99	626	725	
„ 11—15	132	7	252	259	
„ 16—20	3	0	25	25	
In 1918					
			Overwintering Generation		
May 10—15	60	0	4	4	In 1918 the pear-trees were all Japanese sand pear.
„ 16—20	420	0	19	19	
„ 21—25	447	0	19	19	
„ 26—31	170	0	4	4	
June 1— 5	11	0	1	1	

Table III (Continued)

Date of Oviposition	Peach	Pear			Remarks
		Fruit	Other parts	Total	
			First Generation		
June 10—15	136	1	16	17	
„ 16—20	90	0	6	6	
„ 21—25	176	0	6	6	
„ 26— July 1	129	0	2	2	
			Second Generation		
July 8—10	31	0	0	0	
„ 11—15	138	0	0	0	
„ 16—20	411	24	7	31	
„ 21—25	324	11	6	17	
			Third Generation		
Aug. 9—10	14	0	0	0	
„ 11—15	125	7	3	10	
„ 16—22	160	30	4	34	
			Fourth Generation		
Aug. 23—25	21	10	16	26	
„ 26—31	6	16	1	17	
Sept. 1— 5	4	13	15	28	
„ 6—10	29	86	117	203	
„ 11—15	52	60	115	175	
„ 16—20	2	11	40	51	
In 1919					
			Overwintering Generation		
April 16—20	0	0	0	0	
„ 21—25	18	0	0	0	
„ 26—30	8	0	0	0	
May 1— 5	260	0	8	8	
„ 6—10	662	0	36	36	
„ 11—15	414	0	18	18	
„ 16—20	176	0	0	0	
„ 21—25	45	0	0	0	

Table III (Continued)

Date of Oviposition	Peach	Pear			Remarks
		Fruit	Other parts	Total	
			First Generation		
June 6—10	722	0	13	13	
„ 11—15	749	2	27	29	
„ 16—20	249	4	44	48	
„ 21—23	44	0	0	0	
			Second Generation		
July 10—15	522	26	161	187	
„ 16—20	338	8	45	53	
„ 21—25	274	20	42	62	
„ 26—28	35	1	14	15	
			Third Generation		
Aug. 13—15	70	157	75	232	
„ 16—18	42	119	173	292	On August 18th all the pear fruits picked off.
„ 19—20	129	0	114	114	
„ 21—25	177	0	289	289	
„ 26—31	92	0	225	225	
Sept. 1— 2	11	0	48	48	
			Fourth Generation		
Sept. 10—15	42	0	172	172	
„ 16—20	29	0	52	52	
„ 21—25	27	0	28	28	
„ 26—27	9	0	2	2	

The careful study of the results shown in table III shows that in the oviposition experiments which were conducted in the cage (size $5 \times 5 \times 5$ ft.), the adult did not show the normal oviposition habit. For, in the first three generations in 1917, i. e., the overwintering, the first and the second, the adults laid an exceptionally large number of eggs on the pear from the spring, compared with the adults of the corresponding generations in 1918 and 1919, for which the large mosquito-net was used.

In table IV the percentages of eggs laid on two kinds of plants are shown, the percentages being calculated from the results shown in table III.

Table IV.

Choice of plants for oviposition (2)

Gener. / Year	Peach					Pear				
	V	I	II	III	IV	V	I	II	III	IV
1917	(70)	(50.7)	(65)	78	24.1	(30)	(49.3)	(35)	22	75.9
1918	96	94.6	95	87.2	18.5	4.0	5.4	5 0	12.8	81.5
1919	96.3	95.2	87.7	(30.3)	—	3.7	4.8	22.3	(69.7)	—

The figures in table IV show clearly that the adults of the first three generations in 1917 displayed an abnormal habit in oviposition. For this reason the figures for these generations are placed in brackets.

In the experiment of 1919, all the pear fruits were picked off on August 18th, and moreover the peach-trees were severely attacked by the shot-hole disease from about August 25th. For this reason the figures for the third generation are somewhat doubtful and they are placed in brackets in the table.

The results shown in table III and IV can be summarized as follows:

1. In the writer's experiments, the adults of the overwintering generation laid a few eggs on the pear-tree, though they did not lay any eggs on the pear-fruit. However, from about the 10th of July on, the adults laid some eggs on the pear fruits. The adults of the first three generations, i. e., the overwintering, the first and the second, preferred the peach to the pear for oviposition. The percentage of eggs that were laid on the pear increased gradually as the season advances, the average percentage laid on the pear was 3.9% in the overwintering generation, 5.1% in the first and 13.1% in the second.

In the third generation the percentage of the eggs that were laid on the pear was larger than in the preceding generations.

However, the choice of plants for oviposition seemed to change under certain conditions in the case of third generation.

Thus, in 1917 and 1918 the adult of the third generation preferred the peach to the pear, while in 1919 the reverse was the case. In the fourth generation the most of the eggs, i. e., from 75.9% to 81.5%, were laid on the pear.

2. In the experiments of 1919, the adults of the third generation laid many more eggs on the pear than on the peach in the interval from August 13th to 18th; i. e., the number of eggs laid on the pear was almost four times as many as the number laid on the peach.

In order to know what change in the oviposition would occur, the writer picked off all the fruits of the pear-tree on August 18th. Then, the number of eggs laid on the peach increased suddenly during the next week and the

number of eggs on the two kinds of trees did not show much difference.

However, from about the 26th on, the number of eggs laid on the peach decreased markedly. This decrease was probably due to the fact that the peach-trees were severely attacked by the shot-hole disease after that time and the leaves as well as the green shoots were badly injured.

3. The adults laid a few eggs on the pear fruit about the middle of June. The number of eggs laid on the pear fruit began to increase from the middle of July and it increased markedly near the middle of August.

From the results of the oviposition experiments summarized above, we may probably conclude as follows:

1. The Oriental peach moth prefers the peach to the pear; when, however, the pear fruit is ripe, the adult is attracted by it and lays more eggs on the pear-tree than on the peach.

2. Therefore, when a peach orchard and a pear orchard are situated close to each other, the majority of the adults of the overwintering generation which appear in the spring in the pear orchard, will migrate to the peach orchard, and lay their eggs on the peach leaves. This is the reason as seen by the writer for the very few infested shoots of the pear in the spring in the vicinity of Kurashiki. If, however, the adults emerge in the spring in a pear orchard, in the neighbourhood of which peach-trees or other plants suitable for the food of the larva are not found, they will lay their eggs on the pear-trees.

3. From about the middle of July on, the adults which emerge in a peach orchard will migrate in a large number to neighbouring pear orchards. While, before this time, the number of adults in the pear-orchard is very small.

Now, it has been observed that the adults which appear in the spring in Korea lay their eggs on both the fruit and the leaf of the pear-tree; and that in Shizuoka Prefecture the young, green pear-fruits are attacked in the early summer by the larvae of the Oriental peach moth. This is apparently different from the writer's field observation in the vicinity of Kurashiki. The difference in the habits of this insect is perhaps due to the difference in circumstances of the surroundings.

Some Japanese writers seem to think that the Oriental peach moth changes its habit of oviposition according to the generation to which it belongs, and that the adults of the overwintering or of the first generation never lay their eggs on the pear.

The writer thinks, however, that the change in the oviposition habit is not necessarily correlated with the generation; rather it is correlated with the time of the season in which the adults emerge. This seems to be apparent from the results of the writer's experiments on oviposition; and MURAMATSU's observation in Korea that the adults of the first generation, which appear near the end of June or the beginning of July, lay their eggs on the pear fruit, seems to corroborate the writer's views.

The reason why a great many of the Oriental peach moth, which are thriving in the peach orchard in the spring and in the early summer, go to attack the pear is not well known.

The writer thinks however that the attraction of the flavour of ripening fruits is an important cause; another cause is the fact that near the end of July the peach-trees produce only a few young, growing shoots; and that there are only few young shoots left on the peach-trees on account of repeated attacks, is still another important cause of the migration, as has been suggested by QUAINTANCE and WOOD.[1]

Preoviposition Period.

The writer found that most of the adults begin to oviposit from one to ten days after emergence. Generally, a somewhat longer preoviposition period of eight or nine days is needed for the adults of the overwintering generation and a shorter time for the other generations. In the warm summer, some of the adults begin to oviposit on the day of emergence.

WOOD and SELKREGG[2] have found that the preoviposition period of the Oriental peach moth is from two to twelve days in the United States. The results of the writer's observations are therefore, very close to their results.

The Number of Eggs laid.

Number of eggs that an insect lays is sometimes inferred from the number of eggs which are found in the ovary by dissection. This method, however, does not give an exact estimation, for it can not be expected in the case of the Oriental peach moth that all the very small eggs which are found in the ovarian tubes reach maturity and are deposited while the adult is alive.

If so, then, it can not be determined how many of the eggs will be laid during the life period of the adult. Since the adult sometimes lays its eggs on the day of emergence, it must have some ripe eggs even on the day of emergence. And, some of the immature eggs will possibly grow, reach maturity, and be oviposited later.

The writer fed several adults for a few days after their emergence, and then dissected them in order to know whether it is possible to tell by the dissection the number of eggs that the Oriental peach moth will lay. In this moth the ovary of each side consists of four ovarian tubes of the type in which the eggs and the nutritive cell groups alternate. These ovarian tubes open to a short oviduct and the right and the left oviducts unite to form a vagina. The writer classified the eggs in an ovarian tube into two groups, the mature and the immature eggs.

Eggs which are found in about the lower half of an ovarian tube, in the

---

1) QUAINTANCE, A. L. and WOOD, W. B., Jour. Agric. Res., VII, pp. 373—377, 1916.

2) WOOD, W. B. and SELKREGG, E. R., Jour. Agric. Res., Vol. XIII, pp. 59—72, 1918.

oviduct or sometimes in the vagina are large and not accompanied by nutritive cells, are termed mature eggs; while eggs which are found in the upper half, smaller in size and accompanied by masses of nutritive cells are termed immature eggs.

As we proceed to the upper end of an ovarian tube the white immature eggs become gradually smaller, and at last we reach germarium where distinction between eggs and nutritive cells can no more be made. Of the immature eggs only those which are large and situated in about the lower 2/3 of an ovarian tube, and the mature eggs were counted by dissection and the numbers are shown in table V.

Table V.

Number of Eggs found by Dissection.

Adult	Kinds of Eggs	Vagina	Right Oviduct	Left Oviduct	Right Ovarian tubes	Left Ovarian tubes	Totals of ripe and unripe	Total for the adult
No. 1	mature	1	1	1	18	19	40	61
	immature	0	0	0	10	11	21	
„ 2	mature	2	2	1	23	25	53	65
	immature	0	0	0	5	7	12	
„ 3	mature	1	2	1	9	15	28	—
„ 4	mature	0	2	0	22	22	46	—
„ 5	mature	—	—	—	—	—	37	—

According to the table given, the number of mature eggs is from 28 to 53, and the average number for a female is 40.8. If we suppose that the immature eggs which are situated in the lower 2/3 of the ovarian tubes will develope and be oviposited, then we obtain 65 as the maximum number of eggs that a female will lay.

Now, what was the actual record of the number of eggs that a female laid? In table VI the writer will show the results of the experiments regarding this point. The results that were obtained in 1916 are omitted in the present paper.

Table VI.

Number of Eggs laid.

Number of individuals	Total number of eggs laid	Average number per female	Remarks
14	576	41.1	Observations in the mosquitonet.
16	351	21.9	
22	545	24.8	
33	1646	49.8	
28	1854	66.2	

According to the observation in 1916, the number of eggs per female varied from 5 to 65. This conspicuous variation was probably due to the improper method of experiments. Perhaps, five or seven eggs per female does not represent all the eggs that an adult can oviposit.

According to the results shown in table VI, the average number of eggs per female is from 21.9 to 66.2. Now, when we compare this record with those results which were obtained by dissection, we see that the maximum number laid by a female in these two cases is in good agreement, if we assume that some of the well developed immature eggs reach maturity and are deposited. That is, we can guess the approximate number of eggs that a female can lay by examining the contents of the ovary by dissection.

However, the exact number of eggs to be laid can not be told by this method. For, if we assume some of the immature eggs are also to be laid, the criterion by which we decide whether an immature egg will be laid or not, is by no means definite.

Light reaction.

As has been stated, Oriental peach moths hide under leaves or rest on branches during the day. In this respect, they may be said to shun daylight. However, they fly about from about three o'cloch afternoon, when the weather is cloudy; and when it is fine, they begin to move about just before sunset.

It has been observed that, when the adults are confined in a dark room with one or two small windows which are closed with paper, and through which dim light enters the room, they gather at the window. In this respect they seem to share a character of an ordinary night-flying moth and show the tendency to go to a light of certain intensity which is suitable for them.

The writer tried to capture the Oriental peach moth by a coal oil lamp, but failed to attract it. However, a few moths were sometimes seen coming to an electric lamp, so that the light reaction of this moth seems to deserve a further study.

Longevity of the adult.

The results of observation regarding this point are shown in table VII.

Table VII.

Longevity of Adult.

Date of Emergence	Date of Death	Longevity (in days)	Date of Emergence	Date of Death	Longevity (in days)
April 12	April 25	13	June 20	June 25	5
May 2	May 15	13	August 7	Aug. 13	6
„ 5	„ 17	12	„ 8	„ 18	10
„ 5	„ 20	15	Sept. 3	Sept. 10	7
„ 9	„ 21	12			

The records in the table seem to indicate that the longevity is affected by temperature and humidity. In April and May the temperature of air is lower and the humidity is higher than in the other months; and as a consequence the longevity is much longer in these months. The maximum longevity was found to be 15 days.

3. Egg and Larva.

Egg Period. Some of the results of observations regarding the incubation period is shown in table VIII.

Table VIII.

Incubation Period (Egg period)

Generation	Date of Oviposition	Date of Hatching	Egg period (in days)
First Generation	April 22	May 3	11 days
	„ 24	„ 4	10 „
	May 14	„ 20	6 „
	„ „	„ 24	10 „
Second Generation	June 2	June 9	7 „
	„ 12	„ 16	4 „
	„ „	„ 18	6 „
Third Generation	July 13	July 18	5 „
	„ 9	„ 12	3 „
	„ 10	„ 15	5 „
Fourth Generation	Aug. 8	Aug. 12	4 „
	„ 10	„ 15	5 „
	„ 14	„ 17	3 „
	„ 8	„ 15	7 „
Fifth Generation	Sept. 5	Sept. 9	4 „
	„ 13	„ 17	4 „
	„ 19	„ 22	3 „
	„ 20	„ 25	5 „

As is seen in the table, the length of the incubation period varies markedly in different months. In April some eggs require eleven days for hatching, while in July, August and in September the egg period is sometimes only three days. The difference in the length of egg period is chiefly due to the different temperatures.

Larval period. Observations show that the length of the growing period

of the larva is within the following ranges:

First generation	from	17	to	24	days
Second „	„	10	„	16	„
Third „	„	12	„	15	„
Fourth „	„	11	„	16	„
Fifth „	„	16	„	23	„

Figures shown above are approximate ranges of the lengths of the larval periods. As this length is affected by climatic conditions, lengths of larval periods observed in other parts of Japan may be sometimes different from the figures shown above. Moreover, in the first and the last generations the period may sometimes be slightly longer, according to the time of appearance of the larva. However, the results obtained in Niigata and Shimane are found to be within the limits shown above.

IV. Food Plants and Fruit Injury.

In the writer's first report the following were listed as the food plants of the larva of the Oriental peach moth:

Sand pear, (Fruits and shoots)
Japanese flowering cherry, (Shoots)
Pear, (Fruits and Shoots)
Cherry, (Shoots)
Apple, (Fruits and shoots)
Plum, (Shoots)
Umé (Japan apricot, *Prunus umé*) (Shoots)
Sand cherry, (Shoots)

Since that time the following have been observed to be attacked:

Quince, (Shoots and fruits)
Apricot, (Shoots and fruits)

In the following lines the writer will give a few remarks on the more important food plants of the Oriental peach moth.

Peach. Peach shoots are attacked severely by this insect. In some cases 80 or 90% of the young shoots may be infested. Though in the United States the larva of the Oriental peach moth is regarded as a bad pest of the peach (the fruit and shoot), it does not injure the fruit of the peach so severly in Japan.

We have, however, not yet accurately studied the extent of the fruit injury of the peach by this insect. In Japan there is a very serious pest of the peach which is often mistaken for the Oriental peach moth larva. This insect belongs to quite distinct species; it is *Carposina sasakii* Matsu., (*Carpocapsa persicana* Sasaki), the adult insect of which is easily distinguishable from

the Oriental peach moth.

The Oriental peach moth is dreaded in Japan as a serious pest of the sand pear rather than the enemy of the peach. Perhaps, the Oriental peach moth is the most serious pest of the sand pear in Japan. The larva is sometimes seen attacking young, green peach fruits in the spring or in early summer.

However, the lavae of the first and the second generations seem to prefer the shoot to the fruit in the case of the peach-tree.

Sand pear. In the case of the sand pear, the Oriental peach moth seems to prefer the fruit to the shoot, especially when the ripening period approaches. The adult lays its eggs on the ripe pear and the newly-hatched larvae bore directly into the fruit. In certain prefectures in Japan the fruit injury of the sand pear is seen from the early summer. In the vicinity of Kurashiki, however, the larvae begin to injure the fruit generally near the middle of July.

This is apparent from the writer's oviposition experiments and the results of observation in the pear orchard shown in table IX.

Table IX.

Time of Appearance of Fruit Injury in Pear.

Name of Variety	Total number of fruits examined	Number of Infested Fruits	Date of Examination
Chojuro (early)	166	0	July 17
„	177	2	Aug. 8
„	221	4	„ 12
„	276	11	„ 26
„	236	43	„ 26
Doitsu	68	0	July 17
„	94	2	„ 21
„	64	0	Aug. 8
„	74	4	„ 26
Okusankichi (late)	86	0	July 17
„ „	154	0	Aug. 12
Akao (early)	202	3	July 21
„ „	84	2	Aug. 26
Asahi	185	1	July 21
Waseaka	122	1	„ „
Edoya	83	0	„ „
Hakuteiryo	61	0	„ „
Azumanishiki	53	0	„ „
„	47	11	Aug. 26

The Chojuro and Doitsu are two early ripening varieties of the sand pear, which are very commonly cultivated in Japan. As is seen in the table, no infested fruits of the Chojuro were found on July 17th; and from this time on the percentage of injured fruits rose gradually. The Okusankichi is a late variety, and in this variety we did not find any infested fruit even on August 12th. There is a general belief that the fruit injury is severer in the late ripening variety. For instance, it is stated that in varieties which ripen earlier than the Chojuro, the fruit injury is small and that late varieties such as the Okusankichi are severely attacked. In 1919 the writer began observation to study the relation between the extent of the fruit injury and the period of ripening. No conclusion can be drawn from the results of just one year's study. However, some of the results are shown in table X to give an approximate idea as to the extent of the fruit injury in the sand pear.

Table X.

Variety and Extent of Fruit Injury.

Name of Variety	Number of fruits examined	Number of infested fruits	Percentage of infested fruits	Time of Picking
	A. In Asakuchi-county			
Doyo	1248	194	15.5%	From July 29th to 31st
Chojuro	1067	134	12.6	„ Aug. 27th „ 28th
Nijisseiki	990	110	11.1	„ Sept. 12th „ 15th
Meigetsu	917	421	45.9	„ „ 12th „ 17th
Hinomaru	920	229	24.9	October 11th
Okusankichi	893	68	8.5	„ 18th
	B. In Orchard of the Institute			
Doitsu	74	4	5.4%	August 26th
Akao	84	2	2.4	„ „
Taihaku	145	19	13.1	„ 30th
Awayuki	59	14	23.7	Sept. 8th
Kurumanashi	55	15	27.3	„ 11th
Waseaka	102	7	6.9	„ 18th
Hinoshita	42	0	0	„ „
Hakuteiryo	41	10	24.4	October 23rd

Injury to other fruit trees. The extent of injury to the other fruit trees has not been studied. In certain localities growing the apple in Japan, however, the apple fruit is attacked to some extent. The quince is much liked by this insect. But this fruit is not of economic importance in Japan.

V. Band Experiment.

Bands were sometimes used as a control method of the codling moth larvae. It consists in tying bands or strips of a certain cloth around the trunk or branches of the apple-tree and in killing the larvae (or pupae) that gathered under the bands to make cocoons. This does not seem promising as a control method of the Oriental peach moth larvae. For, in the case of this insect there are many broods and time of occurrence of two consecutive generations overlaps each other, so that collecting and killing must be done very frequently. This is perhaps too laborious to be a practical method.

The writer, however, conducted the band experiment with a quite different object, i. e., as a method of studying the behavior of the larva. The experiment was conducted in the peach orchard of the Institute. The collection of larvae (or pupae) was done mostly on every two to four days. The record of the experiment is shown in table XI in a much simplified form.

Table XI.

Band Record.

Date	Total No. captured	Average No. captured per day	Date	Total No. captured	Average No. captured per day
In 1917			In 1918		
July 13—17	25	6.3	July 12—13	23	11.5
„ 18—21	6	1.5	„ 14—16	51	17.0
„ 22—25	7	1.7	„ 17—19	100	33.3
„ 26—30	22	4.4	„ 20—22	106	35.3
„ 31—Aug. 6	28	4.0	„ 23—25	46	15.3
Aug. 7—10	8	2.0	„ 26—27	21	10.5
„ 11—16	36	6.0	„ 28—30	97	32.3
„ 17—20	12	3.0	„ 31—Aug. 2	117	39.0
„ 21—25	54	10.8	Aug. 3— 5	92	30.7
„ 26—30	41	8.2	„ 6— 9	52	13.0
„ 31—Sept. 6	40	5.7	„ 10—12	54	18.0
Sept. 7—14	12	1.5	„ 13—15	52	17.3
„ 15—22	13	1.5	„ 16—17	27	13.5
In 1918			„ 18—20	23	7.7
July 2— 5	20	6.7	„ 21—23	19	6.3
„ 6— 8	28	9.3	„ 24—26	16	5.3
„ 9—11	10	3.3	„ 27—29	19	6.3

Table XI (Continued)

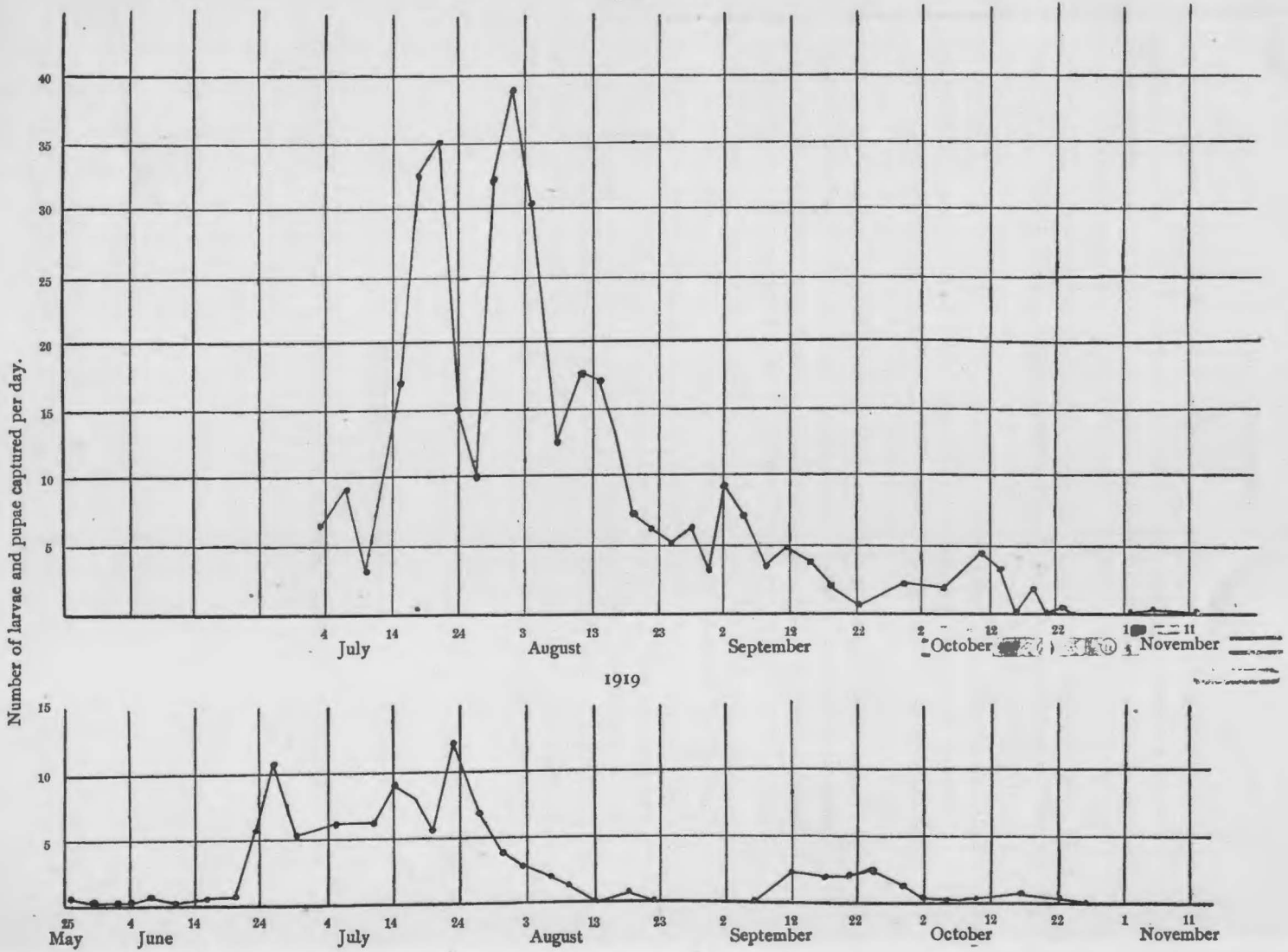
Date	Total No. captured	Average No. captured per day
In 1918		
Aug. 30—31	7	3.5
Sept. 1— 3	29	9.7
„ 4— 6	22	7.3
„ 7— 9	11	3.7
„ 10—12	15	5.0
„ 13—16	16	4.0
„ 17—19	7	2.3
„ 20—25	5	0.8
„ 26—Oct. 2	17	2.4
Oct. 3— 8	13	2.0
„ 9—12	19	4.7
„ 13—14	7	3.5
„ 15—17	0	0
„ 18—19	4	2.0
„ 20—21	0	0
„ 22—23	1	0.5
„ 24—25	0	0
„ 26—28	0	0
„ 29—Nov. 1	0	0
Nov. 2— 8	3	0.4
„ 9—13	1	0.2
In 1919		
May 24—27	2	0.7
„ 28—30	1	0.3
„ 31—June 2	1	0.3
June 3— 5	1	0.3
„ 6— 8	2	0.7
„ 9—12	1	0.2
„ 13—18	4	0.6
„ 19—21	2	0.7
„ 22—24	17	5.7

Date	Total No. captured	Average No. captured per day
In 1919		
June 25—27	32	10.7
„ 28—30	17	5.7
July 1— 9	56	6.2
„ 10—12	19	6.3
„ 13—15	27	9.0
„ 16—18	24	8.0
„ 19—21	17	5.7
„ 22—24	36	12.0
„ 25—28	28	7.0
„ 29—31	12	4.0
Aug. 1— 3	9	3.0
„ 4— 7	9	2.3
„ 8—10	4	1.3
„ 11—13	0	0
„ 14—16	0	0
„ 17—19	2	0.7
„ 20—23	0	0
„ 24—27	0	0
„ 28—Sept. 1	0	0
Sept. 2— 4	0	0
„ 5— 7	0	0
„ 8—15	18	2.3
„ 16—18	6	2.0
„ 19—22	8	2.0
„ 23—25	7	2.3
„ 26—Oct. 2	9	1.3
Oct. 3— 5	1	0.3
„ 6— 8	0	0
„ 9—13	1	0.2
„ 14—18	3	0.6
„ 19—23	1	0.2
„ 24—28	0	0
„ 29—Nov. 2	0	0
Nov. 3—11	0	0

The record in the table shows that the climax of pupation generally occurs near the end of July or of August and after that time the number of pupation decreases conspicuously. If we show the results in the table graphically, taking the average numbers of captured insects on ordinates and the dates on abscissae, the fact just mentioned is apparent at a glance. (See the graph. on page 257.) In 1918 and 1919, it is seen that there are two points of maximum pupation before the end of August and after that time there occur no such high points. This means that the number of insects pupating in the peach orchard has much decreased. The writer thinks that this decrease probably indicates that majority of the moths have begun to migrate to the neighbouring pear orchards.

During the band experiment the writer observed that most of the larvae make their cocoons on branches and trunks. A few were observed on the trunks very near to the soil. The writer saw only one or two larvae during the whole period of his experiments, which made the cocoons in the cracks of the dried soil. The writer thinks that the larvae do not like to pupate in the soil, though a few of them may be found there under certain conditions.

Graph showing the results of band experiments.



Summary.

1) The Oriental peach moth seems to be widely distributed among the prefectures where the peach or the pear is grown. However, there are many localities in which the Oriental peach moth is not yet found, notwithstanding the fact that the peaches, cherries or pears are grown there.

2) The Oriental peach moth produces four or five generations a year in most of the prefectures in the Main Land of Japan. The larvae of the last generation hibernate.

3) The larvae of the Oriental peach moth injures the young shoots and the fruits of the sand pear, pear, peach, apple and the apricot. Moreover, the shoots of the Japanese flowering cherry, cherry, plum, Japan apricot (*umé*) and the sand cherry are also injured.

4) Time of the emergence of the adult in the spring varies according to the climatic conditions. However, emergence generally occurs between the middle of April and the middle of May. The larvae generally injures the shoots of the peach, cherry, Japanese flowering cherry etc. in the spring and early summer and from about the middle of July most of them attack the fruit of the sand pear.

5) The imago oviposits chiefly on the leaf of the peach when it emerges in a peach orchard. In the case of a pear orchard it lays its eggs mostly on the ripe fruit. While the pear is young and hard, the adult prefers the peach-tree to the pear-tree on which to oviposit. When the pear is ripe, the adult seems to be attracted by the fruit and a large part of the adults which appear in a peach orchard migrate to the neighbouring pear orchards.

Acknowledgments.

The author wishes to express sincere thanks to professor E. O. Essig for his kindness in reading through the manuscript and also for kindly advice.
