The Serpentine Leaf-Miner of The Peach, A Species of *Lyonetia*.

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I. Introductory Remarks.

A considerable amount of attention has been paid in Japan for a long time to a species of leaf-miner belonging to the genus *Lyonetia* Hb. as one of the important peach pests. Sasaki first described this leaf-miner in 1903[1] and again in 1910.[2]

However, its complete life-history has not been worked out until 1909, when Kuwana and Takachiho studied this insect at the Imperial Agricultural Experiment Station, Tokyo, and published their result in 1911.[3]

In their paper they used *Lyonetia clerkella* L. as the specific name of this peach leaf-miner. Since that time no one seems to have studied the life-history of this insect, though there are a few more descriptions[4] of it. In Europe *Lyonetia clerkella* L. has been known since the time of Linnaeus. And the accounts of this insect are numerous. Stainton[5] described it in Great Britain as early as 1859; in Germany Heinemann described this species in his celebrated work[6] which was published from 1863 to 1870 and stated in that work that it was very common on the Continent. Theobald[7] reported that it had done considerable injury to the apple in a certain district of Great Britain. Spuler[8] gives the description of it in his "Schmetterlinge Europas," and Reh[9] wrote a brief account of it in Sorauer's "Pflanzenkrankheiten."

Lyonetia clerkella L. which all these European authors have discussed seems not to be the same species as the serpentine peach leaf-miner which has been studied in Japan, though these two are very closely allied. The serpentine leaf-miner which we are discussing here does not occur in abun-

1) Sasaki, C. Dōbutsu-gaku Zasshi, No. 181, pp. 381—383, 1903.
2) Sasaki, C. Kaju Gaichū Hen, 4th Ed., pp. 56—58, 1910.
3) Kuwana, I. and Takachiho, N. Rpt. Imp. Agr. Exp. St., Tokyo, No. 38, pp. 99—102, 1911.
4) Fukaya, C. Jitsuyō Engei-shokubutsu Gaichū Kujo-hō, 2nd Ed., pp. 204—207, 1915.
5) Stainton, H. T. British Butterflies and Moths, Vol. II, p. 424, 1859.
6) Heinemann, H. v. Die Schmetterlinge Deutschlands und der Schweiz, II Abt., II Bd., S. 703, 1863—1870.
7) Theobald, F. V. Second Report on Economic Zoology, pp. 37—41, 1904.
8) Spuler, A. Die Schmetterlinge Europas, II Bd., S. 422, 1910.
9) Sorauer, P. Pflanzenkrankheiten, III. Aufl., III Bd., S. 245—246, 1913.

dance every year, but occassionally it does such severe injury that most of the peach-trees in an orchard are almost defoliated.

Since the summer of 1915 we have been studying the life-history of this insect and the results obtained will be reported in the present paper.

II. Distribution.

This insect has been found in Tokyō, Kanagawa, Hyōgo, Chiba, Saitama, Shizuoka, Toyama, Okayama, Kyūshū, Okinawa[1] and Morioka. Whether this insect occurs in Hokkaidō or not, is still in doubt, although an apple pest[2] which is probably the same as *Lyonetia clerkella* L. in Europe has been found there.

III. Life-History and Habits.

i) Number of Broods.

The method of studying is the same as in the case of the rearing of the Ornix peach leaf-miner[3]. The record of the rearing is as follows:

Table 1.
Records of Rearings.

In 1916

Generation	I	II	III	IV	V	VI	VII
Oviposition	—	June 12—13.	July 2—3.	July 18—19.	Aug. 12	Aug. 29	Sept. 22
Hatching	—	„ 17—	„ 7—	„ 20—	„ 16—	Sept. 3—	„ 29—
Spinning	—	„ 25—	„ 14—	„ 26—	„ 23—	—	Oct. 10—
Pupation	—	„ 27—	„ 15—	„ 27—	„ 24—	—	„ 15—
Emergence	June 11.	July 2—	„ 18—	„ 31—	„ 27—	—	„ 24—

In 1917

Oviposition	—	May 25	June 23	July 12—13.	—	—	—
Hatching	—	„ 29—	„ 26—30.	„ 15—18.	—	—	—
Spinning	May 11—	June 11—	July 3— 5.	„ 24—	—	—	—
Pupation	„ 14—	„ 13—	„ 5— 6.	„ 27—	—	—	—
Emergence	„ 23	„ 20—24.	„ 9—	Aug. 2—	—	—	—

In 1918

Oviposition	—	May 27—	June 24—	July 17—	Aug. 6—	Aug. 31—	Sept. 24—
Hatching	—	„ 31—	„ 27—	„ 20—	„ 12—	Sept. 6—	Oct. 2—
Spinning	May 7—	June 13—	July 3—	„ 25—	„ 19—	„ 15—	„ 13—
Pupation	„ 10—	„ 16—	„ 6—	„ 27—	„ —	„ —	„ —
Emergence	„ 19—23.	„ 22—	„ 10—	Aug. 2—	„ 25—	„ 22—	„ 25—

1) Kuwana, I. and Takachiho, N. loc. cit.
2) Matsumura, S. Ōyō Konchyū-gaku, I Ed., pp. 488—489, 1917.
3) See another paper by the same authors in this "Heft."

The rearing was carried on in three seasons, that is, in 1916, 1917 and 1918. On June 10, 1916 we collected pupae of the miner in an orchard near Kurashiki and the rearing was begun; these pupae were those of the first brood of that year. In 1917, we began with the third instar larvae that had been collected on May 3. The adults of the last brood of 1917 which had been overwintering in the outdoor breeding cage produced the first brood of this year (1918); we did not however observe when they began to oviposit and when the eggs began to hatch. As is seen in the table, the adults which had emerged on July 31, 1916, did not lay any eggs and we substituted for them the moths which had emerged on August 10—12. The larvae which had hatched on September 3, 1916, died on account of some unknown cause; so, we confined some moths which had emerged on September 15, in the cage; but these did not lay any eggs. Again, we confined several moths on September 20. In this way the rearing was suspended twice for 36 days. This year we were able to carry on the rearing without interruption. From the result of rearing and the observations in the orchard during these three years, we conclude that this peach leaf-miner produces seven generations in a year. The seventh generation will probably be a partial one.

Kuwana and Takachiho[1] have already observed that this species has seven generations in the vicinity of Tokyo. *Lyonetia clerkella* L. in Europe has been described as having two broods both in England[2] and on the Continent[3].

Length of three stages. Kuwana and Takachiho reported that the length of the egg, the larval and the pupal stage is about 7, 10 and 7 days, respectively. The results of our observations are shown in table II.

Table II.

Length of Egg, Larval and Pupal Stage.

Egg Stage (in day)

generation / year	I	II	III	IV	V	VI	VII
1916	—	5	5	2	4	5	7
1917	—	4	3	3	—	—	—
1018	—	4	3	3	6	6	8

1) Kuwana, I. and Takachiho, N. loc. cit.
2) Theobald, F. V. loc. cit.
3) Sorauer, P. loc. cit.

Larval Stage (in day)							
generation / year	I	II	III	IV	V	VI	VII
1916	—	10	8	7	8	—	16
1917	—	15	9	12	—	—	—
1918	—	16	9	7	9	12	14
Pupal Stage (in day)							
1916	—	5	3	4	3	—	9
1917	9	7	4	6	—	—	—
1918	9	6	4	6	—	—	—

The length of each stage varies with the season in which the miner is found. Thus, the period of one life-cycle is from 16 to 32 days; the length of the egg stage is from 2 to 8, that of the larval stage from 7 to 16 and that of the pupal stage from 3 to 9 days. We were not able to determine the length of the egg and the larval stage of the first brood.

ii) Imago.

Description.

(a) Morphological. Head with tuft of long scales; face smooth. Antennae as long as forewings, with basal joint broadened, which, together with its scales on the front margin, forms an "eye cap." Proboscis not well developed; palpi drooping in the dried specimen; no maxillary palpi. Simple eyes absent. Thorax smooth. Abdomen with complicated genitalia in the male and with pointed ovipositor in the female. Forewings narrow; apex prolonged into a long cauda; hindwings lanceolate, costal margin of basal portion projecting forwards, with one frenulum in the male and two in the female. Neuration of the wing shows some difference from that of *Lyonetia clerkella* L. described by Heinemann and Spuler. Some of the important points are described in the following lines. Forewing: I short; $II_{2,3}$ not branched, II_5 goes to apex; $III_{1,2}$ not branched, coalescent with II_5 for a distance, sometimes rudimentary; when rudimentary, the point at which $III_{1,2}$ starts from II_5 is easily recognizable; III_3 developed; V hardly visible; a with a large elongated loop at its base.

Hindwing: I very short; II simple; $III_{1,2}$ coalescent with II for a long distance, not well developed; III_3 absent; IV simple; all the other veins wanting. Expanse 8—9 mm.

(b) Colour and pattern. For the sake of convenience, we describe these moths under two headings.

1) *Summer form.* This is the lighter coloured type and appears in the warmer season. Head, tuft of head white. Antennae pale brown. Thorax white, lustrous. Forewings white, lustrous; an oblong or elliptical longitudinal orange to ochreous patch in outer part of discoidal field, periphery of this orange patch dark brown to black; a narrow, inwardly bent black to brown transverse fascia in contact with the outer end of the oblong orange patch just mentioned; just on the outside of this fascia, an irregular triangular, orange to ochreous patch, which is larger than the first oblong orange patch mentioned above; this second orange patch occupies the apical area of the wing surface; three short orange streaks on white fringe along the front-side of this patch; tip and outer margin of each streak dark brown to black; hind margin of the second orange patch black; a dark brown to black streak running from distal end of the second orange patch to hind margin; a black spot at the tip of wing (proper), from which a slender brown candule consisting of long hairs arises; a very short black streak behind the apical spot. Abdomen: dorsal side fuscous; ventral side white, lustrous. Legs: tibia, tarsi of the foreleg brown, other parts white; middle and hind legs white.

2) *Autumn form.* This type appears in the late autumn, and it is darker in colouration. At a glance, it looks dark brown almost all over the body, when it is at rest. Antennae brown. Tuft of head brown. Collar and thorax also brown. Legs dark brown on the dorsal side. Forewings: a longitudinal brown streak arising at the base of wing and reaching to anal angle; this streak varies in its width and darkness in different individuals; in a very dark specimen, it broadens in its width and almost the entire wing surface becomes brown, while in lighter coloured ones the streak is more narrow and the costal area of the wing is white. The fringe is brown. In all cases the pattern in the apical area of the wing, which has been described in the summer form, is clearly seen.

There are intermediate forms between the two forms described above, in which the longitudinal brown streak is merely a light fuscous line.

Habit.

The moth rests on the lower surface of a leaf during most of the daytime. When it is disturbed, it flies; but, soon it conceals itself again under the leaf. The flight is so slow that we can catch it with the bare hand even while it is flying.

The egg-laying occurs mostly during night. The moth seems to take food out of doors, for we have often observed the moth feeding on the honey which had been smeared on the glass door of the cage in the insectary. Theobald[1] thinks that *Lyonetia clerkella* L. does not lay its egg

1) Theobald, F. V. loc. cit.

in the leaf-tissue, though he himself seems not to have seen the egg *in situ*.

The adult of our *Lyonetia* miner always lays its egg in the leaf-tissue according to our observation. The moth has a pretty strong and pointed ovipositor, which it thrusts into the leaf-tissue from the underside of the leaf and introduces one egg into cach hole thus made. Although the egg is laid from the underside, it is found just under the upper epidermis. The position of egg in the leaf is indicated by a slight elevation of the epidermis, circular in outline. The colour of this elevated area is slightly lighter than the other part of the leaf surface, and at the margin of this area there is a small hole which was made by the ovipositor. So that we can tell by careful examination of a leaf with a magnifier, whether that leaf has egg laid in it or not.

Number of eggs laid by a female.

This moth does not lay its eggs generally in the small cage in the laboratory. So it is necessary to rear the insect in a large outdoor cage which covers a small tree grown in the garden. In order to know the approximate number of eggs that one moth can lay, it is more convenient to count the number of the larvae which hatch out of the eggs than to count that of the eggs. The result of the observations shown in table III was obtained in this way.

Table III.

Number of Eggs laid by one Female.

Moth	I	II	III	IV	V	VI	VII
Number of Eggs	132	75	37	77	115	21	113

Food plants of the miner.

As the food plants of *Lyonetia clerkella* L. of Europe, the following have been enumerated[1]:

Crataegus spp.,
Prunus spp.,
Sorbus sp.,
Betula sp.,
Pyrus spp. (including the apple, *p. malus*).

It has been reported that the apple and cherry are attacked most often among these food plants given above. But, in the case of our *Lyonetia* miner, the peach-tree is its most favorite food plant. We have never found the apple nor the cherry attacked by our *Lyonetia* miner. The sand-cherry (*Prunus puvimura*) was the only one *Prunus sp.* which was attacked, other

1) Heinemann, Theobald, Stainton, Spuler and Reh.

than the peach, as far as our observations concern.

Experiment on the oviposition habit of the adult.

Among the plants enumerated above as the food plant of *Lyonetia clerkella* L., four species were used in our experiment concerning the oviposition, i. e., the cherry, apple, plum and the pear (*pyrus communis*). In the summer of 1916 we covered a young shoot with the cheese-cloth bag and several pairs of adults were confined in it. This experiment was repeated several times, but the moth did not lay even a single egg on any of the trees mentioned above.

Imagining that the above result might be due to the imperfectness of the method used, in 1917 we confined a small tree with growing shoots in outdoor cages of the size of $3 \times 2\frac{1}{2} \times 2\frac{1}{2}$ feet. Into each cage at least 15 pairs of adults were introduced and the experiment was repeated two to three times with each of the four species of the plants mentioned above. And, in no case did we succeed in letting the adult to lay its egg. This time we did not consider that it was the method that was at fault. Therefore, we conclude that the Lyonetia moth, which we are dealing with here, does not lay its egg on either of the apple, cherry, pear or plum.

Longevity of the adult. The result of observations are shown in table IV.

Table IV.

Longevity of Moth (in day).

	Moth	I	II	III	IV	V
A	Date of Emergence	Aug. 20	Aug. 23	Aug. 24	Aug. 26	Aug. 27
	Date of Death	,, 25	,, 29	,, 28	,, 31	Sept. 2
	Longevity	5	6	4	5	7
B	Date of Emergence	May 22	June 20	June 20	July 10	July 9
	Date of Death	,, 29	,, 25	,, 26	,, 14	,, 14
	Longevity	7	5	6	4	5

A. Results obtained in 1916, in small cages placed in the laboratory.

B. Results obtained in 1917, in outdoor cages covering a small tree grown in the orchard.

In both case the moths were fed with diluted honey.

iii) Egg.

The egg is laid singly in the leaf-tissue, and several eggs may be found in a leaf. It is whitish in colour, semitransparent and so soft and delicate that it soon shrivels when it is brought out of the leaf-tissue. The egg is almost circular in outline and slightly flattened in shape. The diameter is about 0.22 mm. The egg can be seen by carefully cutting open that part of the leaf epidermis and tissue where it has been laid, under the dissecting microscope.

The incubation period of the egg varies with the season in which it is laid. Thus, in July it is only 2 to 3 days, while at the end of September the egg hatches out on the 7th or 8th day after having been oviposited[1].

iv) Larva.

Fullgrown larva from 5 to 6 mm. in length. Body slightly flattened dorso-ventrally; segments deeply constricted.

Body bluish green in colour; head pale reddish brown; mandible and maxillae brown. Simple eyes on a dark brown patch. Thoracic legs black, jointed, with one curved long black claw at its tip. Four pairs of abdominal legs short, bearing 14 to 15 curved pale yellowish claws arranged in a ring around the tip. Anal legs almost similar to the abdominal in shape and structure, only more flattened. Both the abdominal and the anal legs are of the same colour as the body.

Number of Moults.

The larva does not leave its mine before it is fullgrown and moults twice in the mine. When it is fullgrown, it leaves its mine and begins spinning the cocoon without further moulting. Therefore, the number of the head exuviae in the mine shows the number of moultings. As in the *Ornix* miner, the number of moultings can also be determined by measuring the widths of the heads of larvae in various stages of growth. The results of our studies are shown in table V and VI.

Table V.

Width of Head Exuvia found in a mine and that of the Head of the Last Instar Larva in that Mine (in mm.)

Mine	First Exuvia	Second Exuvia	Head of last instar Larva
No. 1	0.116	0.199	—
No. 2	0.112	0.216	0.332
No. 3	0.122	0.204	0.325
No. 4	0.124	0.226	0.332
No. 5	0.110	0.193	0.319

1) See table II.

Table VI.

Width of Head of Larva (mm.)

I	0.110	0.116	0.119	0.123	0.126	0.129	0.133
II	0.186	0.193	0.196	0.199	0.203	0.206	0.209
III	0.315	0.322	0.328	0.332	0.338	0.345	0.352

Although there is individual variation in the width of head, we can group the results of the measurements into three, shown in table VI as I, II and III. That each group represents the widths of the heads of the larvae of the same larval stage, will be recognized when we compare the result given in table V with that in table VI.

Growth of Larva and its Habits.

Though the egg is introduced into the leaf-tissue from the lower surface of the leaf, it is laid just under the upper epidermis. After hatching the larva feeds immediately on chlorophyll cells and makes an "upperside mine." At first it proceeds, turning mostly to the right. Consequently the tunnel in the leaf-tissue looks like a helicoid figure. Next, the larva tunnels without turning, unless it is interrupted by the larger veins of the leaf. But, the mine is generally sinuous and represents a "serpentine mine." The larva moults for the first time, when it ceases the helicoid tunnelling and moults for the second time a little later. And this is the last moulting. The larva is very small in size before the second moult and grows rapidly after it.

Change in structure and colour during the growth.

The first instar. The newly hatched larva is about 0.5 mm. in length and almost transparent. The head is pale yellow. The first segment is slightly dilated and longer than the other ones. The larva has six rudiments of the thoracic legs and is entirely without both the abdominal and anal legs. The rudiments of thoracic legs are slight projections of the integument, each having a very short process on it. After the larva has taken its first meal, the body looks green on account of the green colour of the alimentary canal.

The second instar. The structure is almost the same as in the first stage. The first body segment is a little more dilated than in the first stage. The rudimentary thoracic legs become a little larger. The body is green all over. The length is from 1.4 to 2.8 mm.

The third instar. The head is light reddish brown, the body green. The larva has three pairs of fully developed thoracic legs, four pairs of abdominal and one pair of anal legs. The first body segment is no more dilated in this stage. While the larva is in its mine, it differs slightly in shape and colour from the fullgrown larva which has already left the mine. The former is more flattened, its body segments are more compressed

together and the colour is green, while the latter is more prolonged and bluish green in colour.

Movement. Though the abdominal legs are well developed in the last larval stage, the larva does not use them for movement, while it is in the mine. Only the thoracic legs have charge of its movement. After the larva has got out of its mine, it uses only the thoracic and the anal legs. So the movement somewhat resembles that of the Geometrid larva.

v) Cocoon and Pupa.

When the larva is fullgrown, it leaves the mine through the upperside of the leaf, cutting open the upper epidermis at the end of its mine. It spins its cocoon usually on the underside of the leaf and at the part where the surface is curved. The larva sometimes uses the leaf in which it has been mining for spinning its cocoon; but, sometimes it drops down on its silk and builds its cocoon on another leaf. The structure of the cocoon and the method of spinning are same as in *Lyonetia clerkella* L.[1)]

The pupa is almost spindle-shaped and about 3.2 mm. in length. It is pale bluish green in colour. The leg, antenna and wing are tightly pressed to the body. The antennae are a little longer than the body. There are two very short conical processes on the head between the bases of the two antennae. The tip of the abdomen is prolonged into two rather long processes. According to Theobald the third segment of the abdomen has a large apical yellow patch and the base of the fourth is also yellow in the pupa of *Lyonetia clerkella* L.

With our Lyonetia miner, these yellow patches are not found in the female pupa, only the male having them.

Observations has shown that these yellow patches are the colour of an internal organ which is found only in the male.

Though the pupa is at first bluish green all over the body, there appear dark markings near the end of the pupal stage.

These dark markings vary their positions and extent by the season in which the pupae are found. Thus, they are found only on the wings in the warmer season, while in the autumn the pupa is dark in colour almost all over the body.

vi) Hibernation.

Theobald states that *Lyonetia clerkella* L. in Europe hibernates as the adult insect. The *Lyonetia miner* in Japan hibernates in the adult stage, too, as has been already observed by Kuwana and Takachiho. It is certain that it passes the winter in a warm protected place. However, it

1) Theobald, F. V. loc. cit.

is very difficult to find the insect hibernating out of doors. We have sometimes seen it in the house near the orchard. Moreover, we succeeded in making this insect hibernate in the outdoor breeding cage in the orchard during the winter extending from the end of 1917 to the beginning of 1918.

vii) Parasites.

Kuwana and Takachiho has reported that the Lyonetia larvae were often attacked by hymenopterous parasites; and four species in all have already been reared there, including the species belonging to the genus *Glyptapanteles* and *Chalicides*, which were found in May. We have also reared several hymenopterous parasites; they have however not yet been identified. In the spring and at the beginning of summer a species of parasite belonging to the family Braconidae was reared from the pupae of the Lyonetia miner. We could not find this species in the late summer and in the autumn.

Four Chalcid parasites of the larva were reared in August and September. Their brief descriptions are as follows:

The first Chalcid is about 0.98 mm. in length and 1.7 mm. in expanse. It is orange in colour, with a black longitudinal band on the thorax and the hind margin of each abdominal segment is also black.

The second Chalcid is about 0.7 mm. in length, 1.3 mm. in expanse. The head and body are black, having greenish metallic lustre. The legs are yellow.

The third Chalcid is about 0.9 mm. in length and 1.7 mm. in expanse. The head is dark brown, the thorax black with a yellow transverse band at the boundary of the pro- and mesonotum. The anterior half of the abdomen is yellow and the posterior black. The legs are pale yellow.

The fourth Chalcid is almost of the same size as the third and very closely resembles it, but differs as follows: in the third Chalcid the dark part has no metallic lustre, but in the fourth the thorax and the abdomen have greenish metallic lustre. Furthermore, the fourth has no yellow marking on the thorax and the vertex of the head is yellow, the occiput is dark yellow.

IV. Taxonomy.

The serpentine leaf-miner of the peach which we have discussed thus far can probably be referred to the genus *Lyonetia* Hb., considering its important characters. Most of the *Lyonetia* miners which have been described in the entomological books in Japan seem to be the same species as the *Lyonetia* miner which we are discussing in this paper. Some of the Japa-

nese authors consider this miner to be identical with the European *Lyonetia clerkella* L. We think, however, there is a question about its correct Latin name; and here we are going to point out some differences which are found between our *Lyonetia* species and *Lyonetia clerkella* L. described by European authors.

1) *Difference in morphological characters.*

According to Heinemann, the genus *Lyonetia* Hb. has the following characters, the rest of them not being mentioned here:

"Vorderflügel schmal, geschwänzt, mit langer Mittelzelle, drei Äste zum Vorderrand, und zwei oder drei in den Saum, usw."

There is the following passage in the description of the genus *Lyonetia* Hb. given by Spuler:

"I kurz, II_1 entweder nach oder vor der Flügelmitte abgehend, $II_{2,3}$ und $II_{4,5}$ ungegabelt, $III_{1,2}$ kann mit $II_{4,5}$ lange verschmolzen sein, III_3 (nach Heinemann bei *prunifoliella*) vorkommen."

Now, with our *Lyonetia* species, there is vein II_5 well developed on the forewing and it goes to the apex of the wing. Even though we do not take this vein into account, yet there are four veins on the costal margin, namely, I, II_1, $II_{2,3}$, and II_4. If "Äste" of Heinemann does not include vein I, then, we can say that there are only three veins on the costal margin. At any rate, vein II_5 seems to have been absent in the specimens which Heinemann had studied, according to his description. Spuler states, too, that in the genus *Lyonetia* Hb. vein $II_{4,5}$ of the forewing is not branched. We have examined fairly many specimens, but we could not find any in which vein $II_{4,5}$ is not branched. The presence of II_5 (that is, branching of $II_{4,5}$) in our species is, therefere, an important difference between the European species of the genus *Lyonetia* and our *Lyonetia* species.

Excepting the difference stated above, the other morphological characters of our *Lyonetia* species are almost the same as those of the European species belonging to the genus *Lyonetia* Hb.

2) *Difference in colour and pattern.*

Also in the colour and pattern, we have found a little difference between our *Lyonetia* species and *Lyonetia clerkella* L. described by Heinemann and Spuler. As we have already stated, our *Lyonetia* species shows remarkable variation in colouration according to the season in which it appears.

Heinemann and Spuler state that *Lyonetia clerkella* L. has darker aberrations, too. It is, therefore, necessary to compare carefully the characteristics of these various forms of *Lyonetia clerkella* L. with those of our *Lyonetia* species.

Heinemann says that the longitudinal patch is brown. In our species it is ochre or it may be called even orange in the lighter coloured form which appears in the summer and this patch is margined with dark brown or black. He does not, however, state anything about this latter point.

The transverse more or less distinct white line described by Heinemann as lying just outside the bent transverse brown line is very rarely distinct in our species.

For, in our specimens, the longitudinal orange patch, the bent transverse brown line and the triangular orange patch following the bent brown line, all these three are in contact with each other. As we have already said, there are gradations in the darkness of colouration in the autumnal forms of our species. In lighter coloured specimens, only a longitudinal brownish line starting at the base of the forewing and reaching to the anal angle, is found; in darker specimens this line becomes darker and broader and especially the dark area extends more and more towards the inner margin. In much darker specimens the inner margin is darker than the costal margin. This seems not to be the case with *Lyonetia clerkella* L. which Heinemann described.

3) *Difference in larval characters.*

Theobald describes the larva of *Lyonetia clerkella* L. as having two dark patches on the first body segment and the eight prolegs are brown to black. But, in our species, there are no such dark patches, nor are the abdominal legs brown. The claws of the abdominal leg are pale yellowish, but these claws can not be seen unless under strong magnification. The abdominal leg itself is almost of the same colour as the body.

4) *Difference in food plants.*

According to Stainton, the larva of *Lyonetia clerkella* L. mines in the leaves of the apple, cherry, etc. in England. Heinemann states that the species is very common and the larva mines in the leaves of several fruit trees, *Crataegus sp.*, *Prunus spp.*, *Sorbus sp.* and *Betula sp.* Theobald states that this species is a pest of the apple and cherry. Spuler enumerates as food plants *Pyrus*, *Prunus*, *Crataegus*, *Sorbus* and *Betula*, and shows the photograph of the mine of this insect in the leaf of the cherry (*Prunus cerasus*). Reh reports as food plants several fruit trees, "Weißdorn" (*Crataegus sp.*), *Prunus*, *Sorbus* and *Betula*, and shows the photograph of the cocoon and mine on the apple leaf. From the above statements, it is certain that *Lyonetia clerkella* L. in Europe feeds upon the leaf of the apple, cherry and some other species of the family Rosaceae. We have, however, never noticed that our *Lyonetia* miner has injured the apple, cherry and plum. The attack of this miner is almost exclusively restricted to the peach. We carried out experiments on the oviposition habit of the adult of this miner with the apple, cherry, pear and plum. And it did not lay any eggs on any of these plants. We can see, therefore, that there are many differences between our miner and the European *Lyonetia clerkella* L. with regard to their food habit.

When we consider all the differences mentioned above, which has been found between *Lyonetia clerkella* L. in Europe and our *Lyonetia* miner, we

are forced to conclude that our *Lyonetia* miner is not identical with *Lyonetia clerkella* L.

At least from the standpoint of economic entomology, they may be better regarded as distinct species.

Before concluding this chapter, we should like to add a few remarks regarding the systematic position of our *Lyonetia* species. The neuration of the forewing of our *Lyonetia* species resembles closely that of the family Phyllocnistidae which is placed by Spuler just before the family Lyonetiidae; the differences are the presence of a loop at the base of the vein *a* and the coalescence of II_2 and II_3 in our *Lyonetia* species.

The neuration and the shape of the hindwing of our species resembles closely that of the family Phyllocnistidae, too. Our *Lyonetia* species seems, therefore, very closely allied to the family Phyllocnistidae, judging from the characters of the wings, and may probably be considered as the connecting link between the family Phyllocnistidae and Lyonetiidae.

Summary.

1) The serpentine leaf-miner of the peach is widely distributed in Japan.
2) This miner produces seven broods in a year and the adults of the last brood overwinter.
3) The colouration of the adult varies greatly with the season in which it appears; the adult which appears in the warmer season is white except the apical portion of the forewing and that which appears in the late autumn is dark brown almost all over the body.
4) This miner feeds almost exclusively on the leaf-tissue of the peach; the apple, cherry, pear and plum are not attacked.
5) The larva moults twice, that is, there are three larval stages, and in the first two stages it has no legs.
6) This species belongs to the genus *Lyonetia* Hb., but it seems not to be identical with *Lyonetia clerkella* L. in Europe.

We wish to express our sincerest thanks to Professor C. Sasaki, Professor S. Matsumura, Dr. T. Miyake and Baron N. Takachiho for their kindness in allowing us free access to their valuable specimens and literature.

Thanks are also due to Mr. C. Tanabe who carried out the rearing experiment of this miner in 1918.

Explanation of Plate VI.

1. Adult, (Summer form). ×4.
2. Forewing of Intermediate form.
3. Forewing of Autumnal form.
4. Peach leaves with mines; upper surface.
5. Peach leaf with cocoons; lower surface.
6. Wings, showing neuration.
7. Tip of abdomen of female moth; ventral view.
8. Tip of abdomen of male moth; ventral view.
9. Portion of leaf showing that place of underside epidermis, where egg is laid.
10. Fullgrown larva. ×6.
11. Pupa. ×15.
12. Tip of abdomen of pupa; dorsal view.
13. Tip of abdomen of male moth; scales removed; ventral view.
14. Tip of abdomen of female moth; scales removed; ventral view.

PLATE VI.

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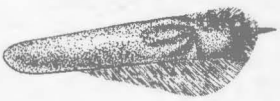

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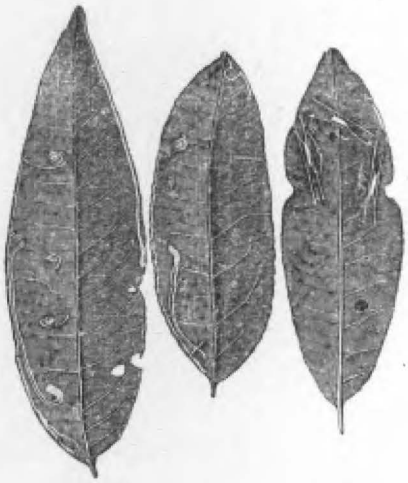

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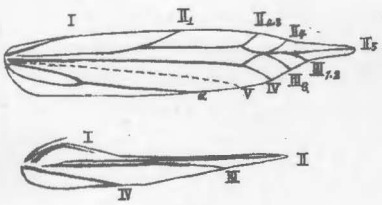

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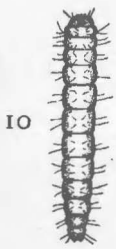

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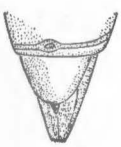

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