ON THE LIFE-HISTORY OF THE APPLE FRUIT-MINER, *ARGYRESTHIA CONJUGELLA* ZELL.

By

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りんごひめしんくひがの生活史に就きて

岡本半次郎

It is a fundamental principle of economic entomology that in order to successfully combat an insect the life history of that insect must be given a keen, searching study. With few exceptions these studies reveal some point in the life of the insect at which it is vulnerable to preventive or remedial measures. Without this knowledge efforts are wasted and in some cases are a positive aid to the insect.

In the present studies upon the apple fruit-miner a particular care has been taken to keep the different stages of the insect during the experiment in exactly the same conditions as to temperature, moisture and light as in the orchard in which the cages were located.

As in other lepidopterous insects, the life of the apple fruit-miner could be divided into four distinct stages—egg, larva, pupa and adult. In winter and early spring, the larva may be found in their cocoons in the soil. Later the larva transforms into a pupa, and this in turn changes to a moth, which in turn lays eggs.

THE EGG.

The egg is flat and oval in shape. It varies in size from 0.38 to 0.48 mm. in length and from 0.25 to 0.3 mm. in breadth. The surface is covered with a network of ridges which are much closer together toward the central portion than around the edge. The color varies with the age of the embryo. When the egg is first laid, it is of a white color, sometimes with a decided yellowish thinge, later becoming light yellowish.

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Places where the eggs are laid—Having never seen the egg, the early writers and horticulturists were forced to guess as to where it was laid. They stated that the eggs were laid on the fruit. These views were held because of the presence of the entrance holes of the larvae on the fruit.

The writer has found that in my orchard the most of the eggs are laid upon the young fruit. In one cage a moth laid 25 eggs, many of which were upon the fruits, and in another cage 29 eggs were laid and only four were upon the leaves. A very few eggs were observed to have been laid upon the leaves in the field.

The average of several rough countings in the field gave an average of about 85 percent laid upon the fruits. Breeding records show that out of 54 eggs in cages, there are 48 eggs upon the young fruits, 6 upon the leaves. A very few eggs are laid upon the underside of the leaves.

We may therefore conclude that the eggs are for the most part laid upon the fruits, while a very few of them may be found upon the leaves.

When the eggs are laid—S. FUJII, *Nōgakushi* stated that the eggs were laid at night. The writer's observations show that the oviposition for the most part is accomplished in the late evening, while a single observation shows an egg to have been laid in the late afternoon.

The number of eggs laid by one female—In only two instances has the writer made a definite observation on the number of eggs laid by a single female moth. Two pairs of the moth were captured in copula, and each was placed in separate cages. In one cage, 25 eggs were found, and in the other, 29 eggs were laid. The average number of eggs laid by one female moth is 27.

The egg-laying period—Upon dissection of the ovaries of the female moth the eggs are found in various stages of development. It is also noted that the eggs are laid when they are in different stages of maturity. From these facts we may conclude that the egg-laying period extends over some time. The length of the time from the emergence of the moth to the beginning of the laying of the eggs varies from 2 to 4 days, with an average of about 3 days.

Hatching of the egg—The egg is hatched in six to seven days in my laboratory at an oridinary room temperature, and in the orchard one day longer. The writer has observed that as soon as the light yellowish tinge of the egg had turned to white, the larva came out of the egg near the one end through an irregular crack

in the shell.

Changes during incubation—The newly laid egg is of a translucent whitish color, often with a yellowish tinge. Observations upon many eggs show that from two to four days with an averagc of three days after the deposition of the egg a yellow ring makes its appearence in its interior. This ring disappears in five to six days and in its place the larva can be seen, the "black spot" which consists of the head and cervical shield, being the most conspicuous part.

THE LARVA.

At the time of hatching the young larva is milky white in color, with large shiny black head, and black cervical and anal shields. The body shows from six to eight regularly arranged dark spots with short hairs.

If hatched upon an apple, a young larva seeks soon a place to enter; when hatched upon the leaves, it may not find any apple for some time, and meanwhile it seems to be obliged to feed upon small portions of the leaves.

Description of the full-grown larva—When full-grown, the larva is about 6 mm. in length. The majority are of a light pink or flesh color, which is much lighter on the under side. The head is brown in color, and the cervical and anal shields are also brown. The segments of the body show from six to eight regularly arranged brown spots, in which the minute short hairs are situated. Beneath the under lip is the spinneret, from which the silken thread is drawn. The larva has eight pairs of legs. The first three pairs are situated on the thorax, and are three jointed. Later these form the legs of the adult insect. The five pairs of the fleshy abdominal legs disappear in the pupal stages of the insect. The first four pairs of abdominal legs are armed with circles of hooks, while the hooks on the two pairs at the end of the body are arranged in a semicircle. The spiracles or breathing apertures of the larva are arranged on both lateral sides of the segments (with exception of the second, third and anal segments) of the body.

How the larva enters the fruit—The place of the entrance of the apple fruit-miner for the most part is on the side of the fruit. It is very common to observe a gummy matter exuding from the place of entrance of the larva. The larva either squeezes its way or tunnels into the fruit. The tunnels are numerous and extend in all directions. A scar or rough spot is a favorite place to enter into, as the jaws slip on the smooth skin.

According to my observations the places of the entrance from 70 to 80 percent are on the sides of the fruit, while from 20 to 30 percent on the stem or calyx.

Time spent in the fruit—From the nature of the case it is most difficult to get exact data on this point, as there are many accidents which may prove fatal to the parasite. On only ten larvae was the writer able to obtain results definite enough to use with any degree of confidence. The average of all these observations is about 50 days. When about full grown the larva makes a passage-way to outside of the fruit and this is usually made toward the side of the apple.

Place of spinning cocoons—The larva on passing out of the apple crawls about on the surface of the fruit, and immediately seeks a place in which to spin a cocoon. If the apple is still upon the tree, the larva lets itself down to the ground by means of a silken thread. If the apple has fallen to the ground the larva simply crawls into the soil and spins there its cocoon. After leaving the fruit the larva is unprotected, and it does not consume much time for entering into the soil.

In an orchard the cocoons are normally found in the earth. But the larva which has been developed later in the season, spins its cocoon sometimes on the inside of boxes or barrels.

The cocoon—The cocoon is composed of silk, secreted by a pair of silk glands, which are situated on either side of the alimentary canal. When a suitable place has been selected for the spinning of the cocoon, the larva begins to weave about itself a single thread of the silk. While spinning the larva is bent upon itself and decreases considerably in size. When the cocoon is completed, which takes usually about one day, the larva straightens out and contracts in length.

The cocoon is spindle-shaped, about 10 mm. in length, and consists of two layers. While the exterior layer may be rough, the interior is always smooth.

The larva hibernates in the cocoon, and in the next early spring, the larval skin is shed and the insect becomes a pupa. The cast larval skin can always be found at the caudal end of the body, shriveled into a rounded mass.

The Pupa.

The pupa is about 5 mm. in length and brown in color. The head, antennae, eyes, mouth parts, legs, and wings of the moth are apparent in sheaths which are immovably attached to the body. The abdominal segments are movable. The

last abdominal segment has a number of long spines with hooks at the end. These hooks are fastend in the silk and aid the pupa in holding its place in the cocoon.

THE ADULT INSECT.

After the pupa has thrust itself out of the cocoon, the pupal skin splits down the back, and the moth forces its way out by spliting away the head end of the pupal skin.

The insect is at first wet, and the body wall is soft. The wings increase several times in size, and as the body dries it grows more rigid. When the wings were fully expanded the moths would often hold them over their backs for a few minutes. The whole process of emergence takes from fifteen to thirty minutes.

The adult insect or moth is quite variable in size. The wings when fully expanded measure from 10 to 12 mm. The length of the body is from 5 to 6 mm. The whole insect is covered with scales having varying color. The body is dark gray. The head covered with long, yellowish white hairs. The antennae are very long and black in color with many yellowish white rings. The anterior wings are dark gray, and very slender. There is a very broad silver-white band along the hind margin, that extends to the middle part from the base of the wing. In the middle portion of the wing a large black band across the wing is to be seen, and a yellowish white spot on the outer margin. On the anterior margin there are many short yellow lines. The posterior wing is smaller and darker than the anterior, acinaciform and margined with long hairs.

Habits of the moth—The moth are but rarely seen in orchards. They spend most of their time resting in the foliage of the apple. When disturbed, they fly away so quickly that the eye is unable to follow them in their erratic flight. According to my observations the moth feed on the water, and are generally not attracted to lights at night.

摘　　要

卵　子

扁平、楕圓、長徑 0.38—0.48、短徑 0.25—0.3 ミ、メ。殼面に網狀の突起を見る。色は胚の熟度に從ふも產卵當時にありては白色、次で淡黃色となる。

產卵場所　主として果面である。一飼育函內の一雌は二十五卵を產み、その大部分を果面に付け、他函內の一雌は二十九卵を產み、うち僅に四卵の葉上にあるを認めた。果園內に於ける數多の計算の平均に見るに、八割五分は果面である、又飼育函內では五十四卵中その四十八は稚果に、その六は葉上にあつた。

產卵時刻　藤井農學士は專ら夜間に產卵すると記するも、余は大部分夕刻に、一部分午後五時頃に產卵することを觀察した。

一雌の卵數　余は僅に二回實驗を試みた。交尾完了の二雌を別々の飼育函に放ちたるに、一雌は二十五を、他雌は二十九を產んだ。その平均は二十七卵である。

孵　化　余の研究室に於ける卵子は約七日にして孵化したるも、果園のものは一日遲れた。而して淡黃色の卵子が、白色となるや否や、幼蟲は卵殼の一端より出づ。

孵化中に於ける變化　始め白色半透明なる卵子が、產卵後三日にして、その內部に黃環現れ、次で五六日を經過しこの黃環消失し、其所に幼蟲の存在を認む、而して頭部、第一節及尾節の硬皮板は所謂黑點となりて現る。

幼　蟲

孵化當時の幼蟲は乳白色にして、頭部、第一節及尾節の硬皮板は黑色なり、体節に六—八個の暗色點を有し、これに短毛を生ず。充分成長すれば体長6ミ、メ、となり。色は所謂肉色となる。頭部、第一節及尾節の硬皮板は褐色を呈し、各節の暗色點は褐色に變る。

蠹入個所　の七八割は果實の側面であつて殘り二三割は蕚筒若くは果梗の附近である。蠹入の初めには果面に常にその場所に飴色の分泌物を見る。果實に蠹入せる幼蟲は約五十日にして老熟する。

紡　繭　老熟した幼蟲は果を辭し紡繭の用意をする。被害果の未だ樹上にある間は、糸を吐きて地上に降下し、果の落下したる時には直ちに地中に入り繭を營む。繭はかくして一般に地中にあるも、幼蟲の發育遲き時は貯藏函中に紡繭する。

繭　紡錘狀にして二層よりなる、而して外層は粗にして、內層は滑なり。長さ 10 ミ、メ。繭を完成するに約一日を費す。

蛹

5 ミ、メ。褐色。腹部の末端に數多の刺を有し、刺の尖端に鈎を有す。

成　蟲

体長 5—6 ミ、メ。翅の開張 10—12 ミ、メ。体暗灰色。頭部に黃白の長毛を密生す、觸角長く、黑色にてこれに黃白輪多し。前翅暗灰色、細長、外緣に長緣毛あり、後緣の內半に銀白色の廣條あり、殆んど翅半に達す、翅の中央に黑色の一橫條あり、尙ほ外緣に近く一黃白紋あり、其他前緣に短黃線多し。後翅は前翅より小にして且つより暗色なり。劒狀を呈し、長緣毛を裝ふ。

蛾の習性　蛾は常に繁茂せる葉間に靜止す、人若し枝葉を攪亂すれば蛾は急速力にて飛翔し、その行先を見きわめ難し。一般に火光を慕はず。