TECHNICAL REPORT ON DEVELOPING WILD SILK INDUSTRY IN VIETNAM

1962 - 1963

OVERSEAS TECHNICAL COOPERATION AGENCY

TOKYO, JAPAN

Foreword

There are several species of wild silkworms in Vietnam and they will make a great property of the country, in case they are developed into a silk industry.

In order to develop the wild silk industry in Vietnam Dr. Katsumata made some surveys and examinations on the Tusser silkworm and the Atlas moth silkworm during the term of his duty as a Japanese Colombo Plan expert on sericulture to Vietnam.

This booklet is a collection of his reports recommended to the government of the republic of Vietnam, including a paper, "Degumming examinations in cocoons of Atlas moth, Philosamia atlas L. by Dr. S. BITO".

September 16, 1963

Overseas Technical Cooperation Agency,

Japan

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1. THE TUSSER SILK INDUSTRY IN VIETNAM AND ITS ASPECT

by Dr. F. KATSUMATA

In summer we can see many Tusser silkworms (Antheraea mylitta) and their cocoons on Bang Lang trees (Lagerstroemia speciosa P.) in Saigon. During the period, from the middle of July to the end of August, we can observe this wild silkworm in all its stages: eggs, infant larvae, grown larvae, cocooning ones, cocoons with living pupae and adult moths.

It is said that this Tusser silkworm is of a bivoltine species, therefore, it is considered that those cocoons with living pupae and adult moths belong to the first generation of the year, and that those eggs and infant larvae belong to the second generation of the same year. From this fact it is believed that the progress of the growth of this species varies very much according to the individual insect.

FEATURES OF COCOONS AND COCOON-FILAMENTS

First of all, we tested the features of the cocoons and the cocoon filaments of this wild silkworm. Materials for examination

were gathered from the Bang Lang trees in Saigon on the end of July 1962. At the time of cooking the cocoons, we tried operations in several concentrated solutions of the sodium carbonate, but we found that cooking the cocoons in water is favorable for reeling operation, and, in reality, we boiled cocoons in water for one hour, during the boiling period cool water was sprinkled on cocoons in order to facilitate the penetration of the water into the cocoon-cavity. After this operation the cocoons were left in the hot water for five hours, then the cooking basin was again warmed to about 90°C temperature and the reeling operation was conducted. The reeling operation was performed by the single cocoon reeling method.

QUALITY OF COCCONS

The weight of a single cocoon is about 8.4 gm. for the female cocoon and 5.39 gm for the male cocoon, the weight of a single cocoon shell is about 0.63 gm. for the female cocoon and 0.53 gm. for the male one, and the percentage ratio of cocoon shell to cocoon weight is 7.5% for the female cocoon and 9.8% for the male one. Details are as follows:

Number of cocoons	Female: Weight of a single cocoon	Female: Weight of a single cocoon shell	Female: Percentage ratio of cocoon shell to cocoon weight	Male: Weight of a single cocoon	Male: Weight of a single cocoon shell	Male: Percentage ratio of cocoon shell to cocoon weight
	(gm)	(gm)	(%)	(gm)	(gm)	(%)
No.1	8.27	0.62	7.43	5.5	0.56	10.18
2	9.15	0.70	7.65	5.7	0.56	9.82
3	8.85	0.69	7.73	5.8	0.57	9.82
4	7.00	0.50	7.14	5.4	0.50	9.26
5	8.90	0.62	6.96	4.55	0.45	9.89
Average	8.43	0.63	7.5	5.39	0.53	9.8

2) QUALITY OF COCOON-FILAMENTS

The length and weight of the cocoon filaments vary very much according to the individual cocoon, so that, we cannot average the figures obtained by examinations.

As to the length of the cocoon-filaments the longest one measured 615 meters, the shortest one 210 meters and the medium one about 400 meters in length.

Regarding the weight of cocoon-filaments the heaviest one weight 44 cg., the lightest one 18 cg. and the medium one about 30 cg.

The variability in the length and the weight of cocoon-filaments is, needless to say, due to the great difference among the unwinding quality of cocoon-filaments.

The results of examination show that the size of cocoon-filaments may, ordinarily, be 6.0 to 6.5 deniers thick.

Details are as follows:

Number of cocoons	Length of cocoon filaments (m)	Weight of cocoon filaments (cg)	Size of cocoon filaments (denier)	Times broken
No.1	427	33.33	7.76	0
2	337	29.00	6.40	0
3	570	36.25	5.72	0
4	418	25.63	5.54	0
5	210	18.00	7.82	2
6	615	44.38	6.50	0
7	360	30.00	7.50	2
8	469	37.50	7.19	0
9	258	21.50	7.47	1
10	397	27.50	6.23	0

3) COCOON COLOR

The most excellent property of this Tusser silkworm is the white color of cocoons.

FUTURE PROSPECT AND PROBLEMS TO BE SOLVED

The Indian Tusser silkthreads are a very famous, excellent and strong one. Since 1953 the Indian Tusser silk has been an important export goods to the United States of America.

It is needless to say that the Tusser silk industry in Vietnam is very hopeful, but, we think that a lot of this kind of silkthreads should be gathered in order to export it to foreign countries, and that a mass production of the Tusser silk on a commercial base will need to put in much effort for the country, because there is no facilities for improving the Tusser silk industry in Vietnam at the present time. Therefore, if it is required to develope this industry, we must start an experiment to improve the quality of coccons and cocoon-filaments, because as mentioned above, the existing wild Tusser silkworms in Vietnam are very variable in quality of their cocoons.

According to our observations, the point of the cocoon shell, which hinders the unwinding of coccon-filaments, is the upper part of cocoons just under the base of the peduncle. This part of

Tusser cocoons corresponds to the opening point of Philosamia cocoons. Therefore, it is necessary to select and breed the Tusser silkworm race, which has a favorable feature for unwinding the cocoon-filaments.

What is more, outdoor experiments in rearing silkworms and experiments in reeling cocoons are essential for developing the Tusser silk industry in Vietnam.

BEHAVIOR OF ADULT MOTHS

TIME FOR EMERGENCE OF ADULT MOTHS

Like Philosamia moths Tusser silkworm moths emerge in the evening, usually from dusk to about 10 p.m.

FROM EMERGENCE TO THE COMPLETION OF THE BODY CONDITION OF THE MOTHS

When the adult moths emerge, they hang onto their coccons or other substance nearby and stretch their wings, examples are as follows:

IN CASE OF A FEMALE MOTH

About two hours before emergence, the upper portion of the cocoon becomes wet from saliva secreted by the moth. Fifteen minutes before emergence a small hole is pierced in the cocoon shell by the moth. Five minutes before emergence the hole becomes larger and the head of the moth can be seen from the outside. The period required for emergence of a moth is about 40 seconds. At the beginning the emerged moth's wings are shorter than the body, but five minutes after emergence the wings begin to stretch and become about the same length as the body length. Nineteen minutes after emergence, the wings stretch fully and hang over the abdomen. Sixty five minutes after emergence, the wings become normal.

IN CASE OF A MALE MOTH

Fifteen minutes after emergence, the wings stretch fully, and sixty minutes after emergence the body condition seems to become normal.

SIZE OF MOTHS

Size of moths emerging during the first ten days of August, 1962, were as follows:

Number of moths	Female		Male	
	Length of the body (mm.)	Length of the extended wings (mm.)	Length of the body (mm.)	Length of the extended wings (mm.)
No.1	53	166	30	125
2	45	152	30	127
3	43	160	34	141
4	35	160	33	135
5	45	160	30	140
Average	44	160	31	134

LAYING EGGS AND THE LONGEVITY OF MOTHER MOTHS

The moths emerging in the evening mate on the night of the day they emerge or on the following day. Usually the mother moth lays eggs on the night, from the third day after emergence to the day of their death, that is, about one week. They do not lay eggs during the day time, and egg-laying is done from dusk to dawn of the next morning.

NUMBER OF EGGS LAID BY A MOTHER MOTH

Number of eggs laid by a mother moth are 300 to 400 eggs and they are laid for several days, some examples follow:

Number of moths	Number of eggs laid each day		
	No.1	No.2	No.3
	(eggs)	(eggs)	(eggs)
On the night of the third day after emergence	223	172	279
On the night of the fourth day after emergence	127	99	62
On the night of the fifth day after emergence	35	16	0
On the night of the sixth day after emergence	15	22	0
On the night of the seventh day after emergence	28	20	0
On the night of the eighth day after emergence	14	6	died
On the night of the ninth day after emergence	9	4	-
On the night of the tenth day after emergence	1	1	-
On the night of the eleventh day after emergence	1	died	-
On the night of the twelfth day after emergence	died	-	-
Total	453	340	341
Eggs remained in the mother body	0	0	62

LONGEVITY OF MOTHER MOTHS

From the above table it can be seen that the mother moth's life span is from 7 to 10 days in a room with temperature varying from 25°C to 29°C.

WEIGHT OF EGGS

An egg weighs about 7 mg., but it becomes smaller with the later days of deposition.

The days of deposition	Weight of a single egg (mg.)	Number of eggs per one gram (eggs)
Eggs laid on the night of the third day	7.575	132
" fourth day	6.944	144
Eggs laid on the night of the fifth day to the eight day	6.111	163

THE LENGTH OF THE EMBRYONAL STAGE AND THE HATCHING TIME

Eggs laid on the night of the first day of August hatched mainly in the morning of the ninth day of the month. Therefore it can be said that the length of the embryonal stage of this silkworm is about 7 days and several hours. Some examples are sited below:

Time of hatching	Number of larvae hatched	
	Batch No.1	Batch No.2
	(larvae)	(larvae)
4 a.m. - 6 a.m. first day	7. 3	2
6 - 8	135	96
8 - 10	50	16
10 - 12	11	3
12 - 2 p.m.	2	5
2 p.m. - 4	1	5
4 - 6	)	3
6 - 8	)	1
8 - 10	) 3	5
10 - 4 a.m. second day	)	8
4 a.m. - 6	)	1
6 - 8		4
8 - 10		3
10 - 12		2
Unhatched eggs		2

From the table it can be seen that eggs usually hatch in the morning, but a small number of eggs hatch in the afternoon or on the night.

SUMMARY

1. The Tusser silkworm (Antheraea mylitta) exists in Viet Nam. In summer, July and August, this species can be seen in all its stages: eggs, infant larvae, grown ones. cocooning ones, cocoons with living pupae and adult moths.

   It is said that this silkworm is of a bivoltine species, therefore, it is considered that some of the cocoons with living pupae and moths belong to the first generation of the year, and that the eggs and infant larvae belong to the second generation of the same year.

2. The weight of a single cocoon is about 3.4 grams for the female and 5.4 grams for the male. The weight of a single cocoon shell is about 0.63 grams for the female and 0.53 grams for the male. The percentage ratio of cocoon shell to cocoon weight is about 7.5% for the female and 9.8% for the male.

3. The length of cocoon filaments varies very much according to the individual cocoon. The longest one measured 615 meters, the shortest one 210 meters and the medium one about 400 meters in

length.

4. The weight of a cocoon-filaments is also variable greatly, the heaviest one weighed 44 cg., the lightest one 18 cg. and the medium one about 30 cg.

5. The variability in the length and weight of cocoon-filaments is due to the great difference among the unwinding quality of the cocoon-filaments.

6. The size of a cocoon-filaments is 6.0 to 6.5 deniers thick.

7. The color of the cocoon is white.

8. The adult moths usually emerge in the evening, from dusk to 10 p.m.

9. The moths complete their body condition in two hours after emergence.

10. The size of the moths measures about 43 mm. in the body length and 160 mm. in the length of the extended wings for the female moth, and about 30 mm. in the body length and 130 mm. in the length of the extended wings for the male moth.

11. Eggs are laid on the night from the third day to the day of death of the mother moths.

12. Three to four hundred eggs are laid by a mother moth for several days.

13. The mother moth's life span is from 7 to 10 days after emergence.

14. An egg weighs about 7 mg., but it becomes smaller with the later days of deposition.

15. The length of the embryonal stage is 7 days and several hours.

16. The hatching of eggs usually takes place in the morning time, but some eggs hatch in the afternoon or on the night, but those eggs are few in number.

17. The food plants for Tusser silkworms in Saigon:

Bang-Lang Tree: (Lagerstroemia speciosa pers.)

Dau-Tree : (Dipterocarpus alatus)

Sao-Tree : (Hopea odorata).

18. The Tusser silk industry in Vietnam is very hopeful in its natural condition, but a mass production of the Tusser silk-threads on a commercial base will require much effort for the country, because there is no facilities for developing Tusser silk industry in Vietnam at the present time.

19. It is an indispensable matter for developing Tusser silk industry that a superior race in reeling quality of cocoons is selected and bred.

(August 25th 1962)

SUPPLEMENT

According to the later observations, however, it is confirmed that the Tusser silkworm in Vietnam, Antheraea myritta, belongs to the polyvoltine species, therefore this wild silkworm grows over the year in Saigon.

Acknowledgement

The writer appreciates the assistance of Professor Pham-hoang-Ho,

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2. THE MORPHOLOGICAL FEATURES OF THE TUSSER SILKWORM, ANTHERAEA MYLITTA IN SAIGON

By Dr. F. KATSUMATA

1. THE GENERAL MORPHOLOGICAL FEATURES

Egg: The egg is round and flat in shape, its upper surface is a bit concave. The egg is circled by two brown lines at its lateral circumference. The shell is white and the yolk is white with a tinge of green in color.

Larva: The skin of the body is green and the head is brown in color. The golden pearls are observed on the dorsal knobs, especially on the knobs of the second and third segment. The number of the pearls varies according to the individual larva. Sometimes a silver plate is observed on the both lateral sides of the fourth segment covering the spiracle. In the grown larvae the knobs become small violet spots. On each of these violet spots grows a black bristle. The bristle usually is one on a spot in number, but, sometimes on the spots of the lateral sides of the fourth, fifth and sixth segment two bristles are observed. On the dorsal surface of the fourth to tenth segment of the body six yellow bristles are seen, but on the

eleventh segment the yellow bristles are four in number. On the both lateral sides of the first segment we can see two violet spots and on both lateral sides of the second and third segment three violet spots are seen. On these violet spots of the first, second and third segment we cannot see the black bristles. On both lateral sides of the fourth to eleventh segment two violet spots are observed respectively. On both lateral sides of the fourth to eleventh segment of the body a broad yellow stripe is observed, and this stripe is connected with the black zone of the posterior end of the body. The yellow stripe on both lateral sides of the body becomes distinguishable from the third stage on, and its color is brownish yellow in the third and fourth stage, but, in the fifth and sixth stage the stripe bomes yellow.

The black marking on the dorsal side of the first segment is a zone in the first stage, it becomes four black pieces in the second and third stage, but they are lost from the fourth stage on, and that part becomes yellowish green in color from the fourth stage on.

There are three black markings on the posterior end of the body in the first stage, and four in the second stage and one black zone from the third stage on.

Moth: The anterior margin of the forewings is pepper and salt in color, and behind that part a yellow area is located. All wings are yellowish brown in color. In the central area of each wing several irregular brown colored waves are observed, and near the posterior margin of the wings a thick dark brown line is located on each wing. On about the center of each wing a round transparent eye marking is observed.

The antennae of the female moth are slender and those of the male moth are thick.

The body color is the same as that of the wings, but the color of the under side of the body and wings is somewhat grayish than that of the upper surface.

Blood color: The blood is light green in color.

Cocoon: The cocoon is conical in shape without strangulation

and is white in color. It has a peduncle to hang from twigs, but has no hole in the cocoon shell.

2. THE EXTERNAL FEATURES OF THE TUSSER SILKWORM LARVAE IN DISCRIMINATING EACH INSTAR LARVAE

1) The first instar larvae: The body is yellow with a tinge of red in color. This yellow color is due to the many yellow colored knobs on the surface of the body. Many bristles (usually six bristles on a knob) grow on the knobs, and the foot of the knob is black. The head is black in color.

A black marking is observed extending crosswise on the dorsal side of the first segment.

On the posterior end of the body a black marking accompanied by three black pieces is observed.

The body of the newly born larvae measures 6 mm. and that of the first molting larvae 14 mm. in length.

2) The second instar larvae: The color of the skin of the body is green. Many yellow knobs are observed on the surface of the body bearing many black bristles on them. The look of the body

is yellow at the beginning, but, with the advancement of growth it becomes greenish, having a hairy look in general.

The head is blackish brown in color.

The black marking on the dorsal side of the first segment becomes four black pieces and that of the posterior end of the body becomes also four black pieces.

In general the look of the body is hairy. The second molting larvae measure 20 to 22 mm. in length.

The third instar larvae: The head is brown in color and the color of the skin of the body is green, many knobs with bristles are observed on the body, being looked hairy or thorny.

On the anterior part of the first segment a yellow area becomes visible, being somewhat swollen. The blackmarking on the dorsal side of the first segment is the same as that of the second instar larvae. The tops of the knobs on the dorsal side of the second and the third segment (sometimes of the fourth and the fifth segment and so on) are black, these black tops become golden pearls afterwards, and the tops of other knobs are red, bearing many bristles.

The blackish brown zone is made on the posterior end of the body from the four black pieces in the foregoing stage.

On the both lateral sides of the fourth to eleventh segment of the body a broad brownish yellow stripe becomes visible, connecting with the black zone of the posterior end of the body.

In general the third molting larvae messure 30 mm. in body length.

4) The fourth instar larvae: The black marking on the dorsal side of the first segment is lost. The anterior part of the dorsal side of the first segment is yellowish green in color and is somewhat swollen. The broad brownish yellow stripe on both lateral sides of the fourth to the eleventh segment become distinct in the fourth instar larvae. The fourth instar larvae however, are seen to be thorny owing to the plentiful knobs with bristles on their body. The posterior end of the body is the same as that of the third instar larvae.

The head is brown in color.

The fourth molting larvae usually measure 45 to 50 mm.. in body length.

5) The fifth instar larvae: The external features of the fifth instar larvae are about the same as those of the fourth instar larvae. The entire body looks smooth, the knobs on the body surface turning into violet spots with bristles.

The body length is 85 to 90 mm. in length.

6) The sixth instar larvae: Tusser silkworm-larvae sometimes molt five times in their larval stage. The sixth instar larvae are the same as the fifth instar larvae in their external features.

(On the 31st, August 1962)

EXPLANATION OF FIGURES

1. The fist instar larva, showing black markings
2. The second instar larva, showing black markings
3. The third instar larva, showing black markings
4. The fourth instar larva, showing knobs and bristles

5.a - 5.c. The fifth instar larva, showing violet spots and bristles

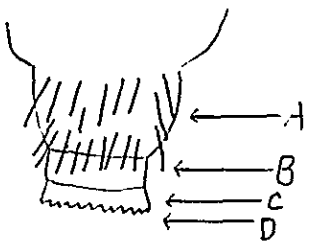
6. The abdominal leg.

A. The skin color is green, bristles are black.

B. The skin colo: is yollowish green, this part is used for expansion and contraction.

C. Pale black colored part

D. Claws



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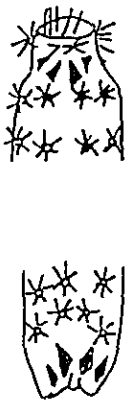

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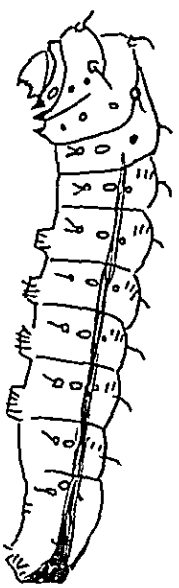

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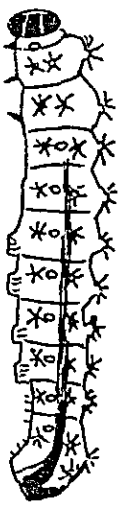

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3. OBSERVATIONS ON THE BEHAVIORS OF THE TUSSER SILKWORM ANTHERAEA MYLITTA

By Dr. F. KATSUMATA

1. THE PERIOD FOR INCUBATION OF EGGS

The eggs were laid in the night, from dusk to dawn of the following day, and were hatched on the morning of the eighth day after deposition, being kept in a room of 25°C to 29°C temperature. Consequently the period for incubation of eggs is about seven days and eight hours.

2. THE LENGTH OF LARVAL STAGE

It is very difficult to rear the Tusser silkworm larvae in a room. In the case of our experiment, 108 larvae were hatched on the 21st day of July and reared indoors for their entire larval stage. Almost all larvae died during the rearing period, being attacked by an intestinal polyhedrosis, and only one cocoon was harvested. On the natural trees the Tusser silkworm larvae grow healthily, but, we cannot observe their behaviors in detail owing to their movement behavior from one leaf to another one. Accordingly it is very

difficult to decide the length of their larval stage and behaviors correctly.

What is more, the progress of the growth of the larvae in earlier stages is uniform, but, in later stages it becomes irregular and some ones molt four times and others five times, therefore the length of the larval stage becomes more complex. Some examples are shown below:

1) THE CASE OF THE FOUR MOLTERS

	No. 1			No. 2		
	Period for eating	Period for molting	Total	Period for eating	Period for molting	Total
	days hours	days hours	days hrs.	days hours	days hours	days hrs.
1st stage	3 . 6	23	4 . 5	3 . 6	23	4 . 5
2nd stage	4 . 1	23	5 . 0	4 . 1	23	5 . 0
3rd stage	4 . 2	1 . 3	5 . 5	4 . 2	1 . 4	5 . 6
4th stage	4 . 21	1 . 16	6 . 15	5 . 19	1 . 22	6 . 13
5th stage	11 . 5	-	11 . 5	12 . 1	-	12 . 1
Entire			32 . 6			34 . 5

Note: No.2 larva died at the 2nd day after mounting.

2) THE CASE OF THE FIVE MOLTERS

	No. 1			No. 2		
	Period for eating	Period for molting	Total	Period for eating	Period for molting	Total
	days hours	days hours	days hrs.	days hours	days hours	days hrs.
1st stage	3 . 6	23	4 . 5	3 . 6	23	4 . 5
2nd stage	4 . 1	23	5 . 0	4 . 1	23	5 . 0
3rd stage	4 . 2	1 . 2	5 . 4	4 . 2	1 . 3	5 . 5
4th stage	3 . 22	1 . 5	5 . 3	4 . 18	1 . 6	6 . 0
5th stage	5 . 19	1 . 17	7 . 12	5 . 18	1 . 16	7 .10
6th stage	(larva died on the 10th day of the 6th stge)			(larva died on the 9th day of the 6th stage)		
Entire stage			more than 36 days			more than 36 days

From the tables the following can be deduced:

1) There are two types in molting behavior, one is four molter and another is five molter.

2) The progress of the growth of the larvae is very variable.

3) The length of the last stage (the fifth stage for the four molter and the sixth stage for the five molter) is extremely long in comparison with thos of other stages.

4) It is said that the length of the larval stage is thirty and several days and it is longer for the five molter than for the four molter.

3. BEHAVIORS OF LARVAE

A) Hatching behavior: The larvae hatch in the morning. After the larvae hatch they eat the egg shell.

B) Behavior of eating leaves: the larvae eat leaves from the edge, even though the larvae are infant just after hatching.

C) Molting behavior: just before casting the skin off, the larva strains itself toward the anterior part of the body, slipping off the old skin backwards. The old skin, at last, breaks at the border of the head and the thorax on both lateral sides of the body, and the newly molted larva comes out of the old skin. The length of the period for casting off the old skin varies according to the age of the larvae.

D) Period for molting and exuviation: the period for molting means the period from the time it ceases eating leaves to the beginning of exuviation, and the period for exuviation means the

period from the breaking of old skin at the border between the head and the thorax to completion of the exuivation. Some examples are shown below:

	Period for molting		Period for exuviation	
	No. 1 (hours)	No.2 (hours)	No. 1 (minutes)	No. 2 (minutes)
1st molting	23	23	4	3
2nd "	23	23	5	4
3rd "	26	27	6	6
4th "	29	42	10	10
5th "	41 (five molter)	(four molter)	18 (five molter)	(four molter)

E) PERIOD FROM THE END OF THE EXUVIATION TO THE COMPLETION OF VARIOUS BODY CONDITIONS

		1st molt (minutes)		2nd most (minutes)		3rd molt (minutes)		4th molt (minutes)		5th molt (minutes)
		No.1	No.2	No.1	No.2	No.1	No.2	No.1	No.2	No.1
From the end of the exuviation	To the beginning of eating the exuviae	133	116	133	112	126	125	131	195	208
	To the end of eating the exuviae	164	136	154	125	142	145	154	205	-

To the beginning of eating leaves	246	221	269	260	256	307	208	305	342

Note: No.1 is a five molting larva and No.2 is a four molting one.

We think that the time of the beginning of eating the exuviae is the time when the body condition of the newly molted larvae is completed.

According to the table it is assumed that the body condition of the larvae, completed the first, second and third molt, is completed about 2 hours after the exuviation, and that, at the time of the fourth molt the body condition of the larvae is completed about 2 hours after the exuviation for the five molter and 3 hours or more for the four molter, and that in case of the five molter it is completed about three and a half hours after the exuviation of the fifth molt.

F) BEHAVIORS OF THE MATURE LARVAE

One day before the mounting, larvae decrease the amount of leaves they eat. At about the noon of the mounting day larvae excrete watery

faeces, but the amount of the watery faeces is a little in comparison with that of the Atlas moth larvae. After that the body size of the mature larvae shrinks considerably.

About seven hours after the excretion of the watery faeces the mature larva starts to spin cocoon. The larvae spin cocoons for about 2 days and turn into pupae about 5 days after mounting. The moths come out of the coccons after 20 days after the mounting. The length of the pupal stage is about 15 days. Same examples are shown below:

No. of mature larvae	Period from mounting to the end of spinning cocoon	period from mounting to the pupation of larvae	Period from mounting to the emergence of moths	Length of the pupal stage
	days hours	days hours	days hours	days hours
No. 1	2 . 0	4 . 15	19. 7	14. 16
2	2 . 5	5 . 0	21. 6	16. 6
3	2 . 0	4 . 20	19. 6	14. 10

4. DISEASE OF TUSSER SILKWORMS

As far as we can determine the disease of the Tusser silkworm larvae in Saigon was all intestinal polyhedrosis. Results are as follows:

Origin of diseased larvae	Age of diseased larvae	Number of larvae tested	Intestinal polyhedrosis
Reared indoors (August 1962)	3rd stage	28 larvae	28 larvae
	4th "	7	7
	5th "	4	4
	6th "	2	2
Wild (July and August 1962)	3rd stage	4	4
	4th "	5	5
	5th "	6	6

SUMMARY

1. The period for incubation of eggs is 7 days and several hours in a room of 25° to 29°C temperature.

2. It is very difficult to decide the length of the larval stage, because the Tusser silkworm-larvae are difficult to rear indoors. There are two types in the molt of the Tusser silkworm-larvae, one is the four molter and another is the five molter.
The progress of the growth of the larvae is very variable. The length of the last stage (the fifth stage for the four molter and the sixth stage for the five molter) is extremely long in comparison with those of other stages. The entire length of

the larval stage is thirty two days or more and it is longer for the five molter than for the four molter.

3. As to the behaviors of the larvae the following are peculiar.

A) The larvae hatch in the morning, and after coming out of eggs they eat the egg shell.

B) Even though the larvae are infant just after hatching, they eat leaves from the edge.

C) At the time of exuviation the old skin breaks at the border of the head and the thorax on both lateral sides of the body and the newly molted larvae come out of the old skin.

D) The period for molting is about 23 hours for the first molt and 41 hours for the 4th or 5th molt. The period for exuviation is about three to four minutes for the first molt and ten to eighteen minutes for the fourth or fifth molt. These periods are variable according to the age of the larvae.

E) The period from the end of the exuviation to the beginning of eating the exuviae is considered to be the period for completion of the body condition after the molting. This period varies according to the age of the larvae. In general, at the time of

the first, second and third molt the body condition of the larvae is completed about 2 hours after the exuviation. But, at the time of the fourth molt the body condition of the larvae is completed about 2 hours after the exuviation for the five molter and 3 hours or more for the four molter, and in case of the five molter it is completed about 3 and a half hours after the exuviation of the fifth molt.

F) At the time of the mounting the larvae shrink their body size, excreting watery faeces. The time of the excretion of the watery faeces is at noon as the mature larvae of Atlas moth do. About seven hours after the excretion of the watery faeces the mature larvae start to spin cocoons. The larvae spin cocoons for about 2 days and turn into pupae about 5 days after the mounting respectively. The moths come out of the cocoons after 20 days after the mounting, therefore, the length of the pupal stage is about 15 days.

4. As far as we can determine the disease of the Tusser silkworm-larvae in Saigon was all intestinal polyhedrosis.

(September 3rd, 1962)

4. COCOON QUALITY OF ANTHERAEA MYLITTA AND LEAVES OF FOOD PLANTS

By Dr. F. KATSUMATA
A Colombo Plan Expert
on Sericulture

About twenty five years ago Mr. T. Yokoyama had reported that the quality of cocoons of Antheraea yamamai reared on young leaves of new shoots of oak trees is superior to that of cocoons spun by larvae fed on hard leaves of old shoots of the trees. About ten years later, Mr. R. TAGUCHI and coworker reported about the same fact.

We observed about the same fect in the cocoon quality of Antheraea mylitta at Saigon in November 1962.

Newly born larvae of Antheraea mylitta were fed on the leaves of Sao tree (hopea odorata) and Dau tree (Dipterocarpus alatus) on the 15th of October 1962 and cocoons were gathered at the final ten days of November 1962. Lots of examinations are as follows:

A..... a lot of silkworms were fed on leaves of Dau tree.

B..... a lot of silkworms were fed on young leaves of Sao tree.

C..... a lot of silkworms were fed on hard leaves of Sao tree.

Quality of cocoons of each lot is as follows:-

COCOONS	FEMALE			MALE		
	Weight of a single cocoon (g)	Weight of a single cocoon shell (g)	Percentage ratio of cocoon shell to cocoon weight (%)	Weight of a single cocoon (g)	Weight of a single cocoon shell (g)	Percentage ratio of cocoon shell to cocoon weight (%)
A (Dau tree) No.1	7.55	0.55	7.3	4.50	0.50	11.1
2	6.40	0.45	7.0	4.40	0.50	11.4
3	7.70	0.65	8.4	4.60	0.60	13.0
4	7.45	0.70	9.4	4.60	0.50	10.9
5	6.95	0.50	7.2	4.00	0.35	8.7
average	7.21	0.57	7.9	4.42	0.49	11.1
B (young leaves of sao tree) No.1	6.60	0.45	6.8	4.00	0.30	7.5
2	5.10	0.30	5.9	4.45	0.30	6.7
3	6.60	0.40	6.1	3.30	0.30	9.1
4	5.70	0.40	7.0	3.50	0.20	5.7
5	6.60	0.40	6.1	3.60	0.30	8.3
average	6.12	0.39	6.4	3.77	0.28	7.4
C (hard leaves of sao tree) No.1	4.70	0.25	5.3	3.00	0.20	6.7
2	4.70	0.25	5.3	3.70	0.20	5.4

3	5.10	0.30	5.9	3.10	0.20	6.4
4	5.00	0.30	6.9	3.10	0.20	6.4
5	5.20	0.30	5.8	3.20	0.20	6.2
average	4.94	0.28	5.7	3.22	0.20	6.2

From the table mentioned above the following conclusion can be drawn:

(1) Cocoon quality of Antheraea mylitta is varaible according to the leaves of food plants.

(2) Quality of cocoons spun by silkworms fed on leaves of Dau trees is superior to that of silkworms fed on Sao trees.

(3) Cocoons of silkworms fed on young leaves of Sao trees are superior to those of silkworms fed on hard leaves of the same trees.

(4) It is considered that these facts are due to the difference in the nutritive value of food plants or leaves.

(5) From these facts it is very important that the rich nutritious leaves are chosen as food for silkworms of Antheraea mylitta.

(June 1, 1963)

Cocoons of Antheraea mylitta spun by silkworms fed on different leaves of food plants.

A ..... Cocoons spun by silkworms fed on leaves of Dau trees.

B ..... Cocoons spun by silkworms fed on young leaves of new shoots of sao trees.

C ..... Cocoons spun by silkworms fed on hard leaves of Sao trees.

5. LIFE CYCLE OF TUSSER SILKWORM, ANTHERAEA MYLITTA, IN SAIGON

By Dr. F. Katsumata

In a previous paper (The Tusser silk industry in Vietnam and its aspect. August 25, 1962) the writer described that Antheraea mylitta in Saigon is a bivoltine type species. However, according to later observations it was revealed that this silkworm belongs to the polyvoltine types and sometimes it shows a long hibernation period in its pupal stage.

This paper deals with the life cycle of Antheraea mylitta in Saigon.

I. THE GROWTH OF ANTHERAEA MYLITTA ON SAO TREE IN SAIGON

In Saigon, for the first time, about the middle of July 1962, the writer discovered cocoons and silkworm larvae of this wild insect on Sao tree (Hopea odorata) and Bang Lang tree (Lagerstroemia speciosa pers). Since then he reared this silkworms on the leaves of Sao tree.

As the first generation in the observation, eleven cocoons made on a Sao tree at Saigon were gathered on the 28th of July 1962. After

that, offsprings from a mother moth of each generation were reared outdoors on the leaves of Sa> trees successively. The choice of the mother moth was performed at random. Results of observations are as follows:

GROWTH OF SILKWORMS IN EACH GENERATION

	1st generation	2nd generation	3rd generation
Emergence of mother moth	Unknown	4 Aug. '62	5 Oct. '62
Egg-laying	Unknown	6 Aug-8 Aug '62	7 Oct-10 Oct '62
Hatching of larvae	Unknown	15 Aug-19 Aug '62	15 Oct-20 Oct'62
Maturity of larvae	Unknown	14 Sep-22 Sep'62	12 Nov-30 Nov'62
Emergence of moths	3 Aug-3 Aug 1962	30 Sep-15 Oct '62	29 Nov-25 Dec'62
Number of moths emerged	11 moths	12 moths	47 moths

	4th generation	5th generation
Emergence of mother moth	13 Dec. 1962	12 Feb. 1963
Egg-laying	15 Dec-18 Dec 1962	14 Feb.-18 Feb. 1963
Hatching of larvae	24 Dec-30 Dec 1962	23 Feb.-27 Feb. 1963
Maturity of larvae	18 Jan-3 Feb. 1963	25 Mar.- 30 Mar. 1963
Emergence of moths	11 Feb.-7 Mar. 1963	18 Apr.-24 Apr. 1963
Number of moths emerged	6 moths	10 moths

From the above table the following points are picked up:

a) Antheraea mylitta in Sagon is of a polyvoltine type, that is, the silkworm has four generations during about nine months from the beginning of August 1962 to the end of April 1963.

b) From this fact it is assumed that this insect can have five generations or more per year fed on leaves of Sao trees in Saigon.

c) On the table above it is noticed that the length of embryo stage and that of larval stage are about the same in each generation, but, the cocoon stage (from mounting of larvae to emergence of moths) in the winter season is somewhat longer than that in the summer season.

As reported in a previous paper (Observations on the behaviors of the Tusser silkworm, Antheraea mylitta, Sept. 3, 1962), the length of cocoon stage of this insect in the summer season is about 20 days, while in the winter season it varies from 24 days to 32 days. A survey on the length of cocoon stage in the winter season is as follows:

A SURVEY ON THE LENGTH OF THE COCOON STAGE IN THE WINTER SEASON

No. of cocoons	Mounting date	Emergence date	Length of cocoon stage	Kind of moths
No. 1	18 Jan. 1963	11 Feb. 1963	24 days	Male
2	18 Jan. 1963	12 Feb. 1963	25 "	Female
3	30 Jan. 1963	25 Feb. 1963	26 "	"
4	30 Jan. 1963	26 Feb. 1963	27 "	"
5	2 Feb. 1963	3 Mar. 1963	29 "	"
6	3 Feb. 1963	7 Mar. 1963	32 "	"

d) Moreover if the deviation ir life-span of silkworms is taken into consideration, it is obvious that the growth of Antheraea mylitta silkworms becomes more complex. As an example, a survey on the life spans of silkworms in the autumnal season of 1962 (the third generation in this examination) will be shown below:

A DEVIATION IN LIFE SPAN OF SILKWORMS HATCHED FROM AN EGG-BATCH LAID BY A MOTHER MOTH

Emergence of mother moth: 5 Oct. 1962, Egg-laying: 7 Oct. - 10 Oct. 1962. Hatching of larvae : 15.Oct. - 20 Oct. 1962, Maturity of larvae: 12 Nov. - 30 Nov. 1962

Emergence of moths:

Date	No. of moths emerged		Date	No. of moths emerged		Date	No. of moths emerged	
	Female	Male		Female	Male		Female	Male
Nov.29	0	3	Dec. 8	0	3	Dec.17	0	1
" 30	0	1	" 9	2	3	" 18	2	0
Dec. 1	0	0	" 10	0	1	" 19	2	0
" 2	0	1	" 11	5	1	" 20	1	0
" 3	0	0	" 12	3	0	" 21	0	0
" 4	1	0	" 13	2	1	" 22	0	0
" 5	0	2	" 14	1	0	" 23	1	1
" 6	1	2	" 15	1	1	" 24	2	0
" 7	0	1	" 16	0	0	" 25	1	0

II. AN OBSERVATION ON THE HIBERNATION OF ANTHERAEA MYLITTA SILKWORMS IN SAIGON

(A) In the case silkworms feed on leaves of Dau trees

In a previous section the growth of Antheraea mylitta on Sao trees in Saigon was described. This section deals with the hibernation of this silkworm. On the 5th of December 1962, thirty three cocoons, spun by silkworms in November and made on Dau tree (Dipterocarpus alatus) in Saigon, were gathered and kept under ordinary room conditions. Emergence of moths was as follows:

A SURVEY ON THE EMERGENCE OF MOTHS FROM THE COCOONS MADE ON DAU TREE AT SAIGON IN NOVEMBER 1962

Date	No. of moths emerged		Date	No. of moths emerged		Date	No. of moths emerged	
	Female	Male		Female	Male		Female	Male
30 Jan.'63	1	0	20 Mar.'63	1	0	31 Mar.'63	1	0
4 Feb.'63	0	1	21 Mar.'63	1	1	2 Apr.'63	0	1
7 Feb.'63	0	1	22 Mar.'63	0	1	3 Apr.'63	1	0
12 Feb.'63	1	0	24 Mar.'63	0	1	4 Apr.'63	1	1
11 Mar.'63	1	0	26 Mar.'63	0	1	5 Apr.'63	1	2
15 Mar.'63	1	0	27 Mar.'63	0	3	7 Apr.'63	0	1
18 Mar.'63	0	1	28 Mar.'63	1	0	10 Apr.'63	0	1
19 Mar.'63	0	2	29Mar.'63	1	2	12 Apr.'63	0	1

From the table it is obvious tht Antheraea mylitta silkworms have a long hibernation period in case they feed on leaves of Dau trees, that is, a major silkworms hibernated for more than four months.

(Supplement: in case eggs laid by above moths are put on Bang Lang tree or Sao tree, silkworms can grow normally).

(B) In the case silkworms feed on leaves of Bang Lang trees

Another example in which silkworms feed on leaves of Dang Lang trees at Saigon in the autumnal season, shows about the same result.

An example of hibernation of Antheraea mylitta in Saigon

Hatching of larvae: Oct. 15th 1962, mounting of larvae: Nov. 15th and 16th 1962 (only two cocoons were made and they were left on the tree outdoors)

Emergence of moths: Feb. 14th and 15th 1963. (two female moths emerged)

In this case the hibernation period is about three months.

CONCLUSION

(1) There are two types of life cycle of Antheraea mylitta in Saigon, one is Sao type and the other is Dau type

(2) Sao type - in case silkworms feed on leaves of Sao trees their life cycle is as follows:

a) Antheraea mylitta silkworms grow all the year round.

b) It is assumed that Antheraea mylitta silkworms have five generations or more per year.

c) The length of embryo stage is from 8 to 9 days, that of larval stage is about 30 days, length of cocoon stage (from mounting of larvae to emergence of moths) is about 20 days in summer and it is somewhat longer in winter, ranging from 24 days to 32

days, and the life-span of moths is from 7 to 10 days.

d) The deviation of life-span of silkworms outdoors is considerably larger, accordingly, the growth of this silkworm becomes very complex.

(3) Dau type - in case silkworms feed on leaves of Dau trees or Bang Lang trees their life cycle is as follows:

a) Pupae, which have developed from larvae in November, have a long hibernation period, showing a long pupal stage of from 3 months to 5 months. Usually these food plants sprout new shoots during the period from May to October, accordingly Antheraea mylitta silkworms can grow in this season (rainy season in Saigon). They may repeat their generation usually 3 times during this season.

b) The life span of Antheraea mylitta of Dau type during the summer season, from May to October, is about the same as that of Sao type one. This fact was confirmed during the period from July to October 1962.

(4) It is considered that the long hibernation period of Dau type silkworms is due to the food plants on which silkworms feed.

(July 1, 1963)

6. OBSERVATIONS ON SPRING MOTHS AND THEIR EGGS OF ATLAS MOTH PHILOSAMIA ATLAS L., IN SAIGON

By. Dr. F. KATSUMATA

In Saigon we can see large moths flying in and out of trees in April and May, and large dark brown cocoons on the branches of the trees. These cocoons seem to us to be suitable for making lap. Therefore, we made some observations about the insect, Philosamia atlas L.

This paper deals with observations on the spring moths emerged from the hibernated pupae and the eggs laid by the moths. It is said that Atlas moth in Vietnam is of a bivoltine species, and the cocoons of the first generation are made in June and those of the second generation are made in September and October. The diapause occurs in the pupal stage in the cocoons of the second generation.

FEATURES OF COCOONS

First of all, cocoon-features were tested. Cocoons for examination were gathered from trees lining the Saigon streets on the 30th of March 1962. The weight of a single cocoon was 9.95

grams, the weight of a single cocoon shell 0.85 grams and the percentage ratio of cocoon shell to cocoon weight 8.50 % for the female cocoon, and the weight of a single cocoon was 7.06 grams, the weight of a single cocoon shell 0.69 grams and the percentage ratio of cocoon shell to cocoon weight 9.70 % for the male cocoon respectively.

Number of cocoons	Female			Male		
	Weight of a single cocoon	Weight of a single cocoon shell	Percentage ratio of cocoon shell to cocoon weight	Weight of a single cocoon	Weight of a single cocoon shell	Percentage ratio of cocoon shell to cocoon weight
	(gm)	(gm)	(%)	(gm)	(gm)	(%)
No. 1	10.1	0.85	8.4	7.8	0.60	7.7
2	9.6	0.85	8.8	7.5	0.60	8.0
3	10.8	0.80	8.3	6.5	0.65	10.0
4	9.2	0.80	8.7	6.8	0.80	11.7
5	10.05	0.95	9.4	6.7	0.78	11.6
Average	9.95	0.85	8.5	7.06	0.69	9.7

EMERGENCE SEASON OF ADULT MOTHS IN SPRING

Moths can be seen from the middle of April to the end of May in Saigon. An example of the survey is shown below:

On the 13th April ..... a male : On the 7th May ..... a female

" 14th " ..... a female: " 15th " ..... a female

" 25th " ..... a female: " 16th " ..... a male

" 26th " ..... two females:

TIME OF EMERGENCE OF ADULT MOTHS

Moths emerge in the evening from dusk to 11 p.m.

FROM EMERGENCE TO COMPLETION OF BODY-CONDITIONS

The moth comes out of a hole, which it has made on the upper end of the cocoon. Emergence takes place without wetting the cocoon shell by saliva of the moth. The period required for emergence is about a half minute.

After emergence the moth hangs onto its cocoon and keeps quiet for about two hours. Hanging is carried out by the second and third legs, resting the first ones, but, when the wind blows all legs are used for hanging

Antennae are always bent backwards during the rest period.

The forewings start to stretch after ten minutes, and the hindwings after fifteen minutes after emergence. All wings stretch fully in 60 minutes after emergence, but they are in soft state. The moth starts to extend all wings in 95 minutes after emergence and becomes normal in 130 minutes after emergence, erecting the antennae.

SIZE OF MOTHS

The length of the body is 47 mm. and that of the extended wings 220 mm. for the female moth, and the length of the body is 37 mm. and that of the extended wings 201 mm. for the male moth.

No. of moths	FEMALE		MALE	
	Length of the body (mm.)	Length of the extended wings (mm.)	Length of the body (mm.)	Length of the extended wings (mm.)
No. 1	45	220	35	200
2	50	225	40	200
3	50	230	35	195
4	45	215	35	195
5	48	225	40	195
6	48	230	35	185
7	46	198	40	230
Average:	47	220	37	201

EGG-LAYING AND LONGEVITY OF MOTHER MOTH

After a female moth has completed its body condition, it mates with a male moth. Usually the female moth is tied onto a branch of the food plant by a thin thread on the night or on the night of the next day, then a male moth comes and mates with the female moth.

The female moth usually deposites its eggs on the morning, from four to five o'clock, of the fourth day and extending over several days after emergence. But some eggs are deposited at dusk, even though they are small in number.

Eggs are deposited one by one or in a mass of several eggs on leaves or branches of the food plants, but some times they fall off from leaves owning to the lack of gluey substance.

NUMBER OF EGGS LAID BY A MOTHER MOTH

About 200 to 300 eggs are laid by a mother moth. Some examples are shown below:

	Number of eggs laid each day	
	No. 1	No. 2
At dawn of the fourth day	190 eggs	158 eggs
" the fifth day	104	91
At dusk of the fifth day	3	15
At dawn of the sixth day	33	10
" the seventh day	17	1
	(died)	(died)
Total	347	275
Eggs remained in mother's body	33	1

LONGEVITY OF MOTHER MOTHS

The longevity of mother moths is about one week.

WEIGHT OF EGGS

An egg measured 1.05 CG. in weight and the number of eggs per one gram was 96.

LENGTH OF THE EMBRYONAL STAGE

Newly born larvae come out of eggs in the morning from 7 to 10 o'clock, and the length of the embryonal stage is 8 days and several hours.

SUMMARY

1. The spring moths of the Atlas moth, Philosamia atlas L., come out of their cocoons in April and May in Saigon. It is said that these moths emerge from diapaused pupae.
2. The weight of a single cocoon is 9.95 gm., the weight of a single cocoon shell 0.85 gm., and the percentage ratio of cocoon shell to cocoon weight 8.50 % for the female cocoon, and the weight of a single cocoon is 7 gm., the weight of a single cocoon shell 0.69 gm. and the percentage ratio of cocoon shell to cocoon weight 9.7 % for the male cocoon.
3. The spring moth comes out of its cocoon at dusk from seven to eleven o'clock.
4. After the moths emerge from their cocoons, they complete their body condition in two hours.
5. The body length measured 47 mm. and the length of the extended wings 220 mm. for the female moth, and the body length was 37 mm. and the length of the extended wings 201 mm. for the male moth.
6. Mating of the moth is usually done on the night of the day it emerges or on the night of the next day. Female moths deposit

their eggs usually at dawn, from four to five o'clock, of the fourth and extending over several days after emergence. Eggs are usually deposited one by one or in a mass of several eggs on leaves of the food trees.

7. The number of eggs laid by a mother moth is 200 to 300.
8. The mother moth lives for one week.
9. The weight of one egg is about 1.05 cg. and the number of eggs per one gram is 96.
10. The newly born larvae usually come out of the eggs in the morning between 7 and 10 o'clock.
11. The length of the embryonal stage is 8 days and several hours.

(August 25th, 1962)

7. THE MORPHOLOGICAL FEATURES OF ATLAS MOTH IN SAIGON

By Dr. F. KATSUMATA

1. GENERAL MORPHOLOGICAL FEATURES

Egg: The egg is round and flat in shape, but the upper surface of eggs is somewhat convex. The shell color is white with a tinge of green, the gluey substance of the eggs is cream-colored, the yolk is white with a tinge of green in color.

LARVA: The skin color of larvae is green with a scattering of a white powder. The thorns on the dorsal surface of the body are very prominent. A red marking is observed on both lateral sides of the third, fourth, ninth, tenth and eleventh segment in the second and third instar larvae, and a red frame marking is observed on both lateral sides of the caudal legs in the fourth, fifth and sixth instar larvae. A distinguishable black antenna is observed on both lateral sides of the first, second and third segment in the third, fourth, fifth and sixth instar larvae. The four dorsal thorns are arranged on each segment extending over the fourth to tenth segment, and the thorns on the eleventh segment are three in number.

Blood color: The blood is light green in color.

Cocoon: The cocoon is large, spindle shaped and dark brown in color, having a hole in the upper end just under the peduncle.

Adult moth: The wings are chocolate-colored. The tops of the forewings are yellow. The forewings have two transparent eye markings each, of which one is larger and triangular, and the other is smaller and long spindle shaped. The hindwings have a transparent eye marking each, the shape of which is about triangular. The posterior end of each abdominal segment is white, and the posterior end of each abdominal segment is white, and the posterior end of the abdomen of the female moth is grayish white in color. The antennae of the female moth are slender and those of the male moth are thick.

2. THE EXTERNAL FEATURES OF THE ATLAS MOTH-LARVAE IN DISCRIMINATING EACH INSTAR LARVAE

1) The first instar larvae: The color of the skin of newly born larvae is yellow, but, with the advancement of the growth it

becomes green, with scattering of white powder. Many bristles grow on the surface of the body. The head is black in color.

2) The second instar larvae: The color of the skin is green, with scattering of white powder. The color of the head is gray at the beginning, but, with the advancement of the growth it becomes brown. On both lateral sides of the third, fourth, ninth, tenth and eleventh segment a red marking is observed.

3) The third instar larvae: The color of the body skin and the red marking on both lateral sides of the third, fourth, ninth, tenth and eleventh segment are similar to those of the second instar larvae. The color of the head is pale green at the beginning, but, with the advancement of the growth it becomes green. The antenna at both lateral sides of the first, second and third segment is distinguishable from the second instar larvae, which are lacking in those antennae. A black bristle is observed on both lateral sides of the tenth and eleventh segment.

4) The fourth instar larvae: The color of the skin of the body is similar to that of the third instar larvae. The head is green in color. The red marking on both lateral sides of the third, fourth,

ninth, tenth and eleventh is lost, and a red frame is observed on both lateral sides of the caudal legs. A black bristle grows on both lateral sides of all segments, from the first to the twelfth segment. Those bristles of the first, second and third segment lay under the antennae.

The four dorsal thorns are observed on the fourth to tenth segment and only three thorns on the eleventh segment. The projection which had been growing on the anterior part of the first segment, becomes scarcely visible.

5) The fifth instar larvae: The external features of the fifth instar larvae are similar to those of the fourth instar larvae, they are different in size only.

6) The sixth instar larvae: The external features of the sixth instar larvae are similar to those of the fifth instar larvae, they are also different in size only. The full grown larvae measured 95 to 100 mm. in their body length.

3. EXUDATION APERTURES OF LARVAE

When we disturb a silkworm in later stages, we can see that

drops of liquid are exuded from the several points of the dorsal side of the body. These drops become brown in color after a while, therefore it is believed that this liquid is the blood of the larva. We can observe fourteen exudation apertures on the dorsal side of a grown larva.

(On the 31st, August, 1962)

EXPLANATION OF FIGURES

1-3. The fourth instar larva, showing larval antennae, thorns and bristles.

4. The sixth instar larva, showing larval antennae, thorns and exudation apertures.

5. The abdominal leg.

   A. Black zone.

   B. The skin color is black and bristles are grayish white in color.

   C. The skin color is azur, this part is used for expansion and contraction.

   D. The skin color is black and claws are black in color.

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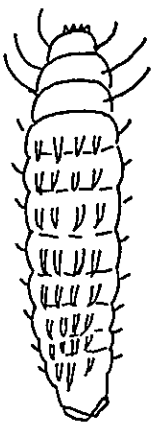

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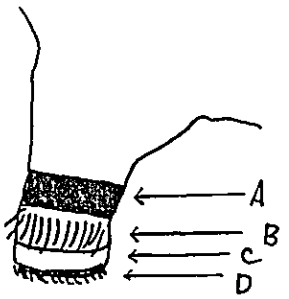

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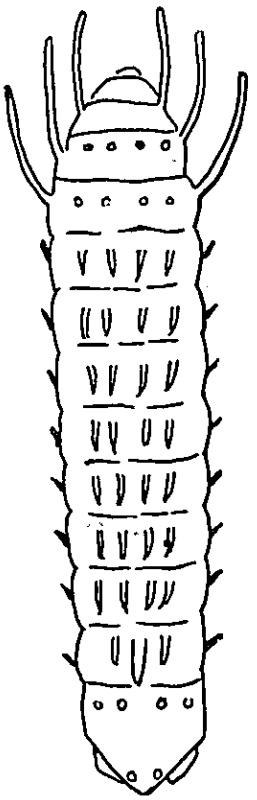

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8. OBSERVATIONS ON THE BEHAVIORS OF THE ATLAS MOTH PHILOSAMIA ATLAS L. REARED INDOORS IN SUMMER, 1962

By Dr. F. KATSUMATA

The eggs for this examination were laid at dawn of the 18th day of May, 1962. They were kept in a room of 26°C to 29°C in temperatur for incubation. The larvae hatched on the morning of the 26th of May between 7 and 8 a.m.

The larvae were supplied with leaves of Cay Ci (Psidium guajava) extending over the entire larval stage and reared in a room with the temperature varying from 25°C to 29°C.

1. LENGTH OF LARVAL STAGE

The length of the larval stage varies very much according to the individual larva, especially the progress of growth of each larva became irregular in later stages, fifth and sixth stage, The beginning of each stage is roughly estimated as follows:

Time for starting each stage

Hatching (first feeding)	2nd stage	3rd stage	4th stage	5th stage	6th stage	Mounting (about 90% of larvae)
10 a.m. 26th May	10 a.m. 30th May	1) p.m. 3rd June	6 p.m. 8th June	6 p.m. 14th June	10 a.m. 24th June	12 (noon) 9th July

LENGTH OF EACH STAGE

1st stage		2nd stage		3rd stage		4th stage		5th stage		6th stage		Total	
days	hours	d.	h.	d.	h.	d.	h.	d.	h.	d.	h.	d.	h.
4	0	4	12	4	19	3	1	9	16	15	4	44	2

ACTUAL LENGTH OF LARVAL STAGE OF INDIVIDUAL LARVA

The above figures are the approximate length of the larval stage, but, the actual length of the larval stage of the individual larva is as follows:

Date of mounting	Actual length of larval stage: days	hours	Female larvae (larvae)	Male larvae (larvae)
July 1	36	2	0	2
3	38	2	1	1
4	39	2	1	1
5	40	2	0	2
6	41	2	4	2
7	42	2	0	1
8	43	2	3	3
9	44	2	1	1
11	46	2	2	0

Note: Larvae used to mature about at noon.

According to the above table, the average length of the larval stage is 40 days 13 hours for the male larvae and 42 days 6 hours for the female larvae. The shortest one was 36 days 2 hours and the longest one was 46 days 2 hours.

2. BEHAVIORS OF LARVAE

A) Hatching behavior: the larvae hatch in the morning, from seven to eight a.m.. After coming out of eggs the larvae eat the egg shell.

B) Behavior of eating leaves: the larvae eat leaves from the edge, even though the larvae are infant just after the hatching. This behavior is different from that of the infant domestic silkworm larvae.

C) Resting behavior in earlier stages: Infant larvae bend the anterior part of their body sideways at the time of rest. This behavior is seen even at the molting period of their infant stages.

D) Molting behavior: just before casting the skin off, the larva straightens it's body and strains itself toward the anterior part, slipping the old skin backwards. The old skin, at last, breaks at the border of the head and the thorax, and the newly molted larva comes out of the old skin, casting it off. The length of the period for casting the old skin varies according to the age of the larvae.

E) Period for molting and exuviation: The period for molting means the period from the time they cease eating leaves to the beginning of the exuviation, and the period for exuviation means the period from breaking the old skin at the border between the

head and the thorax to completion of the exuviation.

	Period for molting		Period for exuviation	
	No. 1	No. 2	No. 1	No. 2
	(hours)	(hours)	(minutes)	(minutes)
1st molting	20	-	2	3
2nd "	16	17	3	-
3rd "	22	20	4	4
4th "	28	29	8	6
5th "	35	34	8	7

Note:- means that the chance for survey was lost.

F) Period from the end of the exuviation to the completion of various body conditions:

From the end of the exuviation	1st molt (Minutues)		2nd molt (minutues)		3rd molt (minutues)		4th molt (minutes)		5th molt (minutes)	
	No.1	No.2	No.1	No.2	No.1	No.2	No.1	No.2	No.1	No.2
To the beginning of stretching dorsal thorns	9	7	6	6	-	-	-	-	7	8
To the end of stretching dorsal thorns	14	10	9	9	10	9	10	10	12	13

To the beginning of blacking of larval antennae					35	26	22	24	34	38
To the end of blacking of larval antennae					-	60	-	-	72	78
To the beginning of eating exuviae	69	60	76	70	87	77	83	98	114	115
To the end of eating exuviae	117	75	92	85	97	99	113	119	163	186
To the beginning of eating leaves	222	100	222	176	184	181	196	183	243	268
To the first excretion	279	230	301	270	272	339	317	417	528	548

Note: (1) - means that the chance for the survey was lost.

(2) Larval antennae can not be distinguished on the body of the first and the second instar larvae.

We think that the time of the beginning of eating the exuvia is the time, when the body condition of the newly molted larvae is

completed.

According to the above table it is seen that the body condition of the second instar larvae is completed about one hour (60-69 minutes) after the exuviation of the first molt and that of the sixth instar larvae is completed about two hours (114 and 115 minutes) after the exuviation of the fifth molt, and the periods for the third, fourth and fifth instar larvae are between the above two.

G) EXCRETION OF SOFT AND WATERY FAECES, AND SHRINKAGE IN BODY-SIZE OF MATURE LARVAE

Larvae begin to shirnk their body-size one day before mounting, and around the noon of the mounting-day they excrete soft and watery faeces, shrinking their body size extremely. The time of excreting the soft and watery faeces is centered around noon, from eleven a.m. to two p.m. and the larvae do not excrete those faeces at any other time. The soft and watery faeces are the last excrements for the mature larvae, and the number of dropping in the soft faeces varies according to the invidual larva, from one to four, and those faeces

are coated with a thin membrane , making a connected line. After the excretion of the soft faeces the watery excrement comes out, being divided into several drops in several times, the watery excrement is brown or light brown in color at the beginning and it becomes colorless at last.

As to the shrinkage in body size of larvae, we surveyed two cases, that is, larvae sized 95 mm. and 90 mm. in body-length at their full grown stage reduced to 70 mm. and 65 mm. respectively after the excretion of the watery faeces.

H). PERIOD FROM EXCRETION OF SOFT FAECES TO SPINNING COCOONS

The periods from the excretion of the soft faeces to the excretion of the watery faeces, the move to seek cocooning places and the time for beginning to spin cocoons are as follows:

		No.1	No.2	No.3
		(minutes)	(minutes)	(minutes)
From the excretion of the soft faeces	To the watery excrement in larger amount	2	5	3
	To the last watery excrement	5	12	10
	To the grasping of twings by caudal legs	9	17	12
	To the move to seek cocooning places	14	21	-
	To the start of spinning cocoons	8 hours	13 hours	9 hours

I). THE BEHAVIOR OF BITING THE PETICLES AND DROOPING THE LEAVES

At the time of making cocoons, larvae bite the petioles and droop them downward to make cocoons on them. Moreover, white power-like-substance is put thereabout by the mature larvae.

This behavior can not be seen at the time of the mounting of Tusser silkworms.

J). PERIOD FOR SPINNING COCOONS

As to the period for spinning cocoons it is generally said that larvae spin cocoons for two to three days, after excreting the last

faeces, for instance, we observed the following cases: a larva spins its cocoon for 5½ hours, the second one for 65 hours and the third one for 72 hours respectively.

K) PERIOD FROM MOUNTING TO PUPATION

Regarding the period for pupation it is generally said that larvae turn into pupae in six to seven days after the mounting. In reality, we observed the following cases: a larva turned into pupa after 6 days 12 hours, 6 days 17 hours, 6 days 19 hours and 6 days 20 hours after mounting.

3. FEATURES OF COCOONS OBTAINED BY THE INDOOR REARING

Cocoons obtained by the indoor rearing are inferior to those produced on the wild trees in quality. The following figures are average values.

	Female			Male		
	Weight of a single cocoon	Weight of a single cocoon shell	Percentage ratio of cocoon shell to cocoon weight	Weight of a single cocoon	Weight of a single cocoon shell	Percentage ratio of cocoon shell to cocoon wieght
	(g)	(g)	(%)	(g)	(g)	(%)
Cocoons indoor	6.10	0.46	7.5	4.42	0.41	9.2
" wild	9.50	0.85	8.9	6.67	0.74	11.1

Note: Cocoons obtained from wild trees were made in the same season as those obtained by the indoor rearing.

4. LENGTH OF PUPAL STAGE (FROM MOUNTING TO EMERGENCE OF THE MOTHS)

The length of the pupal stage varies considerably according to the individual pupa, we obtained the following data surveying this feature of the Atlas moth reared indoors in June, 1962. That is, 25 larvae were mounted at the beginning of July, from the first day to the eleventh day, out of which 18 pupae developed into moths and 7 pupae are yet in their pupal stage at the present time (September 10th, 1962).

The length of pupal stage of each insect is as follows:

Length of pupal stage	Number of moths emerged out of pupae	
	Female	Male
24 days	1	0
25 "	1	3
26 "	3	1
27 "	1	0
28 "	1	1
29 "	1	1
34 "	0	1
45 "	0	2
50 "	0	1
Number of pupae remained in their pupal stage	4	3

Note: In relation to the length of the pupal stage the problem of the diapausing pupae will arise in researches of this insect.

5. SIZE OF MOTHS REARED INDOORS

In accordance with the decrease in the cocoon weight, the size of the moths reared indoors is smaller than that of the wild moths. A result of the survey is as follows:

Number of moths	Female		Male	
	Length of the body	Length of the extended wings	Length of the body	Length of the extended wings
	(mm.)	(mm.)	(mm.)	(mm.)
No. 1	35	195	30	180
2	43	195	30	180
3	40	205	35	180
4	50	200	30	175
5	45	200	30	170

6. NUMBER OF EGGS LAID BY A MOTHER MOTH REARED INDOORS

The number of the egg laid by a mother moth reared indoors is less than that of those eggs laid by a wild mother moth. Details are as follows:

	Number of eggs laid each day				
	No.1	No.2	No.3	No.4	No.5
At dawn of the fourth day after emergence	99	76	46	90	111
At dawn of the fifth day after emergence	11	23	18	29	34
At dawn of the sixth day after emergence	6	29	15	22	14
At dawn of the seventh day after emergence	0	12	8	18	12
At dawn of the eighth day after emergence	0	14	(died)	8	5

At down of the ninth day after emergence	:	(died)	:	5	:		:	2	: 3
At down of the tenth day after emergence	:		:	(died)	:		:	(died)	: 2
TOTAL	:	116	:	159	:	87	:	169	: 181
Eggs remaing in the mother's body	:	2	:	7	:	3	:	8	: 0

7. LONGEVITY OF MOTHER MOTHS

According to the above table the life span of the mother moth reared indoors is about the same as that of the wild moth described in the previous paper.

8. WEIGHT OF EGGS LAID BY MOTHER MOTHS REARED INDOORS

An egg weighs 8.62 mg. and number of eggs per one gram was 116. These values are smaller than those of the wild moth described in the previous paper.

9. FOOD PLANT FOR ATLAS MOTH IN SAIGON

Atlas moth-larvae are fed on the leaves of the following plants.

Cay Ci (Psidium guajava)

Cay Dai Ngua (Swietenia macrophylla)

Cay Khe (Averhoa carambola)

Cay Gao (Nauclea annamensis) ..... discovered by Mr. Ruyen.

SUMMARY

The results of the observations on the behaviors of the Atlas moth reared indoors in summer are summarized as follows:

1. The length of the larval stage varies considerably according to the individual larva. The average length is 40 days 13 hours for the male larva and 42 days 6 hours for the female larva. The shortest one was 36 days 2 hours and the longest one was 46 days 2 hours.
2. As to the behaviors of the larvae the following facts are pointed out:
   A) The larvae hatch in the morning, and after coming out of eggs they eat the egg shell.
   B) Even though the larvae are infant just after hatching, they eat leaves from the edge.
   C) The infant larvae bend the anterior part of their body sideways

at the time of their rest.

D) The period for moltirg varies according to the age of the larvae: the period for tne second molting is the shortest, being about 16-17 hours and the period for the fifth molting is the longest, being 34-35 hours.

E) The period for exuviatiun varies also according to the age of the larvae: the period for the exuviation in the first molt is the shortest, being from 2 to 3 minutes and the period for the exuviation in the fifth molt is the longest, being from 7 to 8 minutes.

F) The period from the end of the exuviation to the beginning of eating the exuviae is considered to be the period for completion of the body condition after the molting. According to the observation this period varies according to the age of the larvae, that is, it is one hour after the first molting and about two hours after the fifth molting, and the periods after the second, third and fourth molting are between the above two.

G) The mature larvae excrete the soft and watery faeces before

spinning cocoons, as the last excrements of the larvae.

H) The mature larvae shrink their body size after excreting the soft and watery faeces.

I) The excretion of the soft and watery faeces is usually around noon, and the larvae begin to spin cocoons about a half day after the excretion of the last faeces.

J) The mature larvae bite the petioles and droop the leaves in order to make cocoons on them.

K) The mature larvae spin cocoons for two to three days after excreting the last faeces.

L) The mature larvae turn into the pupae in six days or seven days after the mounting, that is, after excreting the last faeces.

M) This insect belongs to a five molting race.

3. The features of cocoons obtained by the indoor rearing are inferior to those of the wild ones.

4. The length of the pupal stage (from the mounting to the emergence of the moths) varies considerably according to the individual pupa. In case of our experiment 25 larvae were mounted at the beginning of July and they turned into pupae commonly in seven days after the mounting, out of these 25 pupae 14 moths emerged

in 24 to 29 days after the mounting, one moth after 34 days , two moths after 45 days and one moth after 50 days after the mounting, 7 pupae remain in their pupal stage at present, September 10th, 1962, 2 months after the mounting.

The length of the pupal stages has an intimate connection with the diapause of the pupae. It is said that this insect belongs to a bivoltine species, and the eggs used for this experiment were laid by a moth, which has emerged from a diapaused pupa, therefore, the problem for the voltism and the diapause of this insect should be solved in the future.

5. The size of the moths reared indoors is smaller than that of the wild ones.
6. The number of eggs laid by a mother moth reared indoors is less than that of the wild one.
7. The life span of the mother moths reared indoors is about the same as that of the wild one.
8. The weight of the eggs laid by the mother moths reared indoors is lighter than that of the eggs of the wild ones.
9. As to the food-plant for Atlas moth in Saigon, there are 4 plants.

(September 10th, 1962)

9. AN EXAMINATION FOR MAKING FLOSS-SILK FROM COCOONS OF ATLAS MOTH SILKWORMS

By Dr. F. KATSUMATA

The cocoon-shell of the Atlas moth-silkworms makes a strong tissue, being kneaded by a gummy substance secreted by the cocooning larvae. Consequently, it is hard to reel the cocoon-filaments from the cocoons.

It is, therefore, considered that these cocoon-filaments can be utilized by silk-spinning operation, that is, the strong cocoon-shell be firstly loosened and made into the floss-silk, after that the spun silk yarn be produced.

According to the private communication from Dr. S. Bito, a research officer of the sericultural experiment station of the government of Japan, the cocoon-shell of Atlas moth is to be boiled in a 1/10 normal solution of sodium carbonate for one to two hours in order to loosen the cocoon-filaments in the cocoon-shell.

Taking his advice, we made an examination for making floss-silk from cocoons of Atlas moth.

Materials: Material cocoons were gathered from the trees lining the streets of Saigon on the beginning of October 1962. All cocoons were pierced ones. The exuviae of mature larvae and pupae in the cocoons were taken out by cutting cocoon-shell. 70 grams of the cleaned cocoon-shell were obtained from 100 grams of cocoons, this amount of cocoons being, usually, counted for 100 to 105 in number.

Method: 70 grams of cocoon-shell were boiled in 4 liters of a 1/10 normal solution of natrium carbonate for 90 minutes and left for several hours until they became cool as they are, after that the floss-silk was made and washed thoroughly with water, and the floss-silk was dried up.

Results:

Number of Experiments	Weight of cocoons used (grams)	Number of cocoons used (cocoons)	Weight of cocoon-shell used (grams)	Weight of floss-silk obtained (grams)	Percentage ratio of floss-silk to the weight of cocoons used (%)
I	100	104	70	57	57.0
II	52	50	36	30	57.6
III	51	50	-	26	50.9

Note: In case of experiment III, cocoons were not opened and exuviae were not eliminated. In this case the floss silk obtained was beaten to remove the pieces of the exuviae in it.

REFERENCE:

Bito, S. (1941): chemical studies on the silk-thread of the silkworms. (V) on the degumming of the cocoon-filaments of wild silkworms (in Japanese), Journal of the sericultural science of Japan Vol. 12, No.1.

SUPPLEMENT:

According to the writer's observation, the Atlas moth larvae are healthy by nature, therefore, if they are raised artificially, the spun silk yarn will be made in mass in Vietnam.

(Dec. 20, 1962)

Floss-silk and coccons

10. DEGUMMING EXAMINATIONS IN COCOONS OF ATLAS MOTH, PHILOSAMIA ATLAS L.

By Dr. S. BITO
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The National Sericultural
Experiment Station, Tokyo

In previous paper (J. sericult. Sci. Japan vol 12, No 1, 1941) the writer reported that alkaline solutions have a strong degumming action against the cocoon shell of several wild silkworms and that acid solutions, soap solutions, super heated water and enzime solutions are less effective in the said action.

In September 1962, Atlas moth's cocoons produced at Saigon were sent to the writer from Dr. F. KATSUMATA for determination of the most suitable degumming method for them. The cocoons used for this examination were pierced ones (cocoon shell left by an emarged moth) of the first generation of the year made on trees in Saigon in July 1962. The method of degumming examination is about the same as that described in the previous paper in 1941. The strength of filaments was surveyed by the Schopper type tensile strength testing machine. The figures mentioned below show the average

values of 50 filaments respectively.

Results of examination

(1) As to the alkaline solutions used, solutions of natrium hydroxide, kalium hydroxide, lithium hydroxide, natrium carbonate and natrium silicate have a strong degumming action against the cocoon shell, while solutions of ammonia, natrium bicarbonate and natrium borate have a weak power.

(2) Regarding the acid solutions, the degumming power of hydrochloric acid solution is strong in comparison with solutions of oxalic acid and acetic acid; and later two solutions are less effective in degumming activity.

(4) The degumming power of the soap solution is very weak.

(4) Solutions of hydroxides of alkaline metals injure the fibroin tissue of the filaments to a great extent.

(5) In general, alkaline solutions increase the degumming power in proportion to the increase of concentration and the rise in temperature, on the contrary, the filaments lose strength damaged in their fibroin tissue in such conditions.

In short, according to the results of examinations, solution of natrium carbonate, natrium silicate and natrium hydroxide have a strong degumming power against cocoons of Atlas moth and can loosen the filaments in them; the solution of natrium hydroxide, however, injures the filaments to a great extent, therefore, the first two solutions are recommended for practical use.

Considering the degree of injury to the fibroin tissue of the filaments, it is said that a treatment in a 1/10 normal solution of natrium carbonate for two hours at 100°C is the most favorable method for degumming the Atlas moth's cocoons. (1/10 normal solution of natrium carbonate means that 14.3 grams Na_2CO_3, $10H_2O$ is dissolved in one liter of water).

We can gather good silk filament as meterial for spun silk yarn from cocoons of Atlas moth in case cocoons filaments are loosened by a degumming operation.

Table 1.- Percentage ratio of gummy substance eliminated by the treatment in alkaline solutions

Chemicals	100°C 0,5 hr. (%)	100°C 1 hr. (%)	100°C 3 hr. (%)	100°C 5hr. (%)	110°C 1 hr. (%)
N/10 Li OH	19.08	21.17	-	-	-
" Na OH	16.99	20.32	-	-	-
" K OH	15.68	18.52	-	-	-
" NH_4OH	-	5.62	4.51	6.15	-
" Na_2CO_3	-	11.63	15.16	17.86	16.29
" $NaHCO_3$	-	5.0	5.66	6.77	5.72
" $Na_2 Si O_3$	-	8.45	11.47	17.06	12.90
" $Na_2 B_4 O_7$	-	3.39	6.25	7.28	6.35

Table II - Percentage ratio of gummy substance eliminated by the treatment in acid solutions and soap solution

Chemicals	100 °C 1 hr. (%)	100°C 3 hr. (%)	100°C 5 hr. (%)
o.3% Soap sol.	1.20	1.85	2.43
N/30 HCl	-	-	12.62
N/10 HCl	10.25	12.88	18.89
N/10 CH_3 COOH	4.42	9.14	10.13
N/10 COOH COOH	2.57	6.74	8.65

Table III - Degumming treatment and strength of the Filaments

Chemicals	Concentration	Temperature (°C)	Times (hrs)	Percentage ratio of gummy substance eliminated (%)	Strength of filaments (%)
Na Oh	N/10	100	1	18.08	5.81
$Na_2 CO_3$	"	"	3	15.16	11.48
$Na_2 Si O_3$	"	"	5	18.06	10.99
HCl	"	"	5	18.88	9.17
$Na_2 CO_3$	N	90	1	13.75	12.31
"	N	100	1	14.41	8.26
"	N	100	1	20.72	2.29
$Na_2 CO_3$	N/10	100	1	11.67	11.78
"	N/3	100	1	13.71	11.41
"	N	100	1	14.41	8.26
$Na_2 CO_3$	N/10	100	1	11.67	11.78
"	"	"	3	15.16	11.48
"	"	"	5	18.86	11.18

11. COCOON QUALITY OF PHILOSAMIA ATLAS AND FOOD PLANTS

By Dr. F. KATSUMATA
A Colombo Plan Expert
on Sericulture

In other report (cocoon quality of Antheraea mylitta and leaves of food plants. June 1, 1963) the writer described that the quality of cocoons of Antheraea mylitta is variable according to the leaves of foods plants. This paper deals with the relation between cocoon quality of philosamia atlas and food plants.

Philosamia atlas' cocoons, which are of the second generation of the year 1962, and made on the leaves of Bong-Chua Y-Lan tree (Cananga odorata (Lamk) Hook F.) and Dai Ngua tree (Swietenia macrophylla), were gathered in Saigon city and the quality of them is surveyed as usual.

	FEMALE			MALE		
COCCONS	Weight of a single cocoon (g)	Weight of a single cocoon shell (g)	Percentage ratio of cocoon shell to woecon weight (%)	Weight of a single cocoon (g)	Weight of a single cocoon shell (g)	Percentage ratio of cocoon shell to cocoon weight (%)
No. 1	12.9	1.0	7.8	9.1	0.9	9.9
2	13.5	1.0	7.4	8.45	0.9	10.6
A 3	12.55	1.0	8.0	9.35	0.95	10.2
(Bong-4	14.85	1.25	8.4	9.50	0.95	10.0
chua 5	13.5	1.15	8.5	8.95	0.9	10.0
Y-lan 6	13.85	1.15	8.3	9.85	1.1	11.6
tree) 7	12.8	1.0	7.8	9.50	0.95	10.0
8	14.55	1.25	8.6			

9	13.0	1.0	7.7			
10	14.1	1.2	8.5			
Average	13.56	1.10	8.1	9.27	0.95	10.2

1	8.05	0.5	6.2	6.3	0.5	7.9
2	8.55	0.6	7.0	7.0	0.8	11.4
3	10.45	0.65	6.2	6.6	0.5	7.6
4	10.70	0.85	7.9	6.45	0.65	10.0
5	9.25	0.75	8.1	5.5	0.55	10.0
6	11.65	1.0	8.6	8.15	0.8	9.8
7	10.25	0.9	8.8	6.9	0.75	10.8
8	10.60	0.75	7.1	7.75	0.95	12.2
9	8.50	0.75	8.8	7.65	0.7	9.1
10	9.25	0.7	7.6	8.1	0.75	9.2
Average	9.725	0.745	7.6	7.04	0.695	9.9

From the table the following conclusion can be drawn:

(1) Cocoon quality of philosamia atlas is variable according to the food plants.

(2) Quality of cocoons made on Bong-chua y-lan tree is superior to that of cocoons made on Dai Ngua tree.

(3) It is considered that above fact is due to the difference in the nutritive value of leaves of food plants, accordingly it is very important to choise a rich nutritious plant in order to harvest

good cocoons in quality.

(June 1, 1963)

Philosamia atlas moth's cocoons made on two different plants.

A ..... cocoons made on Bong-chua y-lan tree

B ..... cocoons made on Dat Ngua tree.

12. LIFE CYCLE OF ATLAS MOTH, PHILOSAMIA ATLAS L. IN SAIGON

By Dr. F. KATSUMATA

Regarding the life cycle of Atlas moth, it is said in Saigon that this insect belong to a bivoltine type and winters in a stage of pupae. In reality, we can see a plentiful moths in two seasons at Saigon, April-May and July-August. But a least moths and larvae in number also can be seen in Saigon all the year round. From this fact it is considered that there will be some temporarily emerging moths or poly-voltine-type-ones in this insect. Consequently some investigations were carried out.

I. Emergence of moths out of cocoons reared indoors

Eggs of a batch laid by a wintered mother moth hatched on the 26th day of May 1962. Larvae were reared indoors being supplied with leaves of Oi tree (Psidium guajava) in a room with the temperature varying from 25°C to 29°C. Twenty five larvae were mounted mostly in the first ten days of July (from the first to the eleventh of July). Cocoons were kept in the room with temperature varying from 18°C to 30°C for about one year. Emergence of moths out of these

cocoons is as follows:

A survey of emergence of moths out of cocoons reared indoors

Season of emergence	Number of moths emerged		
	Female	Male	Total
July 1962 final ten days	3	4	7
August 1962 (first ten days	5	3	8
(middle ten days	0	0	0
(final ten days	0	3	3
September 1962	0	0	0
October 1962	0	0	0
November 1962 (27th day)	1	0	1
December 1962 (8th day)	1	0	1
January 1963 (31st day)	0	1	1
February 1963	0	0	0
March 1963	0	0	0
April 1963	0	0	0
May 1963 (first ten days)	0	2	2
(middle ten days)	1	1	2
(final ten days)	0	0	0

From the above table the following facts are pointed out:

(1) Major silkworm moths (numbering 18 moths in this case) emerged in 50 days after mounting. These silkworms can be considered to be the bivoltine type ones.

(2) A least moths in number (numbering 3 moths) emerged temporarily in winter season. These silkworms can be considered to be the unseasonably emerging ones.

(3) Some silkworm moths (numbering 4 moths) emerged in May of the next year. These silkworms can be considered to be the univoltine type ones.

(4) From the facts mentioned above it is obvious that there are three types of silkworms in their development behavior, even though all silkworms are hatched from an egg-batch laid by a mother moth.

II. Emergence of the moths out of the cocoons of the second generation in 1962.

On the 30th day of October 1962, 13 cocoons of Atlas moth, which were of the second generation of the year and made on Dai Ngua tree (swietenia macrophylla) in Saigon, were gathered, and the emergence of the moths out of the cocoons is observed, cocoons being kept in a room with the temperature varying from 18°C to 30°C. Results are as follows:

A survey on emergence of moths out of coccons of the second generation

Season of emergence	Number of moths emerged		
	Female	Male	Total
November 1962	0	0	0
December 1962	0	0	0
January 1963 (7th day)	0	1	1
February 1963	0	0	0
March 1963	0	0	0
April 1963 (first ten days	0	0	0
(middle ten days (11th)	1	0	1
(final ten days (28th)	1	0	1
May 1963 (first ten days	1	4	5
(middle ten days	3	1	4
(final ten days	1	0	1

From the table the following facts are pointed out:

(1) A least moths in number (numbering only one moth in this case) emerged unseasonably in winter.

(2) Major moths have wintered in the pupal stage and emerged in April-May season of the next year.

(3) It is confirmed that there is a unseasonable emerging moth among the cocoons made by the second generation silkworms.

III. Emergence of moths out of cocoons made on wild trees

27 cocoons made on the wild Dai-Ngua tree gathered on the 5th day of November 1962 at Saigon. The generation of these cocoons in the year is unknown. Cocoons were kept in the ordinary room at Saigon. The emergence of moths is as follows:

Season of emergence	Number of moths emerged		
	Female	Male	Total
November 1962 (28th)	1	0	1
December 1962 (13th, 25th, 28th)	0	3	3
January 1963 (23rd)	0	1	1
February 1963 (23rd, 27th)	2	0	2
March 1963 (27th, 31st)	0	2	2
April 1963 (7th, 8th)	1	1	2
(first ten days)	1	2	3
May 1963 (middle ten days)	6	4	10
(final ten days)	3	0	3

According to the table the emerged moths can be divided into two types.

(1) Seven moths emerged during the period from November to February are grouped into the unseasonably emerging type.

(2) Twenty moths emerged during the period from March to May are grouped into the ordinarily hibernating type.

CONCLUSION

From the investigations mentioned above the life cycle of Atlas moth in Saigon is as follows:

(1) Moths of Atlas moth, Philosamia atlas L. usually emerge two times a year, April-May and July-August, and this insect winters in the pupal stage. Major moths belong to this type, that is, to the bivoltine type. The moths of the first generation emerge in the season of April-May, lay eggs. Larvae grow in the season of May-June and turn into pupae in the season of June-July.

The second generations moths come out of cocoons in the season of July-August, lay eggs. Larvae grow in the season of August-September-October, turn into pupae in the season of September-October and the pupae hibernate in their cocoons.

(2) Some moths emerge one time a year, that is, the moths come out of cocoons, which have wintered, in the season of April-May, lay

eggs. Larvae grow in the season of May-June, turn into pupae in the season of June-July; and the pupae winters in their cocoons. These silkworms are of univoltine type.

(3) A least moths in number emerge temporarily in winter season. Theses are the unseasonable emerging type ones.

(4) Even though silkworms are hatched out of an egg batch laid by a mother moth there are three types in their development behavior.

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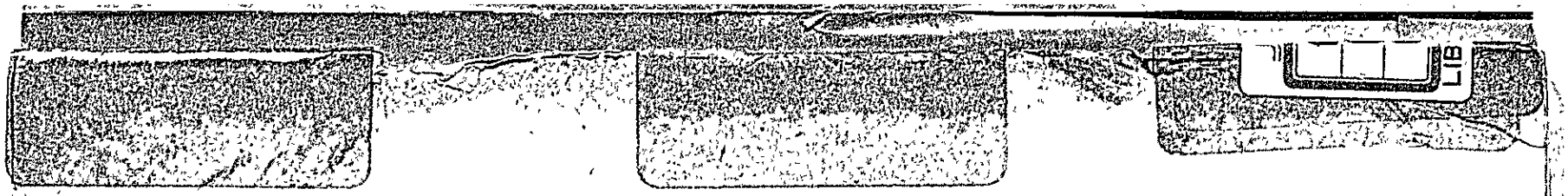
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