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LIFE CYCLE OF *Arthroschista hilaralis* (LEPIDOPTERA: PYRALIDAE) ON JABON TREES (*Anthocephalus cadamba* Miq)

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ABSTRACT

Arthroschista hilaralis is a defoliator pest. Currently, a great number of these insects are attacking Jabon trees, causing a high degree of damage. This study aimed to assess the life cycle of *A. hilaralis* on Jabon (*Anthocephalus cadamba* Miq.) The study was conducted by examining each stage of *A. hilaralis* life development, including the body size and the time required for each stage of *A. hilaralis* development. The results showed that the average time *A. hilaralis* took to complete a life cycle was 25.1 days, consisting of egg stage 2.7 days; larva 12.6 days, pupa 6.9 days and pre-oviposition of imago 2.9 days. Pest management action is required on a regular basis to control this pest development due to the high level of development and the rapid rate of growth of *A. hilaralis*.

Keywords: *Anthocephalus cadamba*, *Arthroschista hilaralis*, life cycle.

ABSTRAK

Arthroschista hilaralis merupakan hama defoliator yang pada saat ini banyak menyerang tanaman jabon dengan tingkat kerusakan yang tinggi. Penelitian ini bertujuan untuk mengkaji siklus hidup *A. hilaralis* pada tanaman jabon (*Anthocephalus cadamba* Miq.) Penelitian dilakukan dengan mengamati setiap tahap perkembangan hidup *A. hilaralis*, meliputi ukuran tubuh dan waktu yang diperlukan *A. hilaralis* pada setiap stadia perkembangan hidupnya. Hasil penelitian menunjukan bahwa rata-rata waktu yang diperlukan *A. hilaralis* menyelesaikan satu kali siklus hidupnya adalah 25.1 hari, dengan lama stadium telur 2.7 hari; larva 12.6 hari, pupa 6.9 hari dan masa praoviposisi imago 2.9 hari. Diperlukan tindakan pengelolaan hama secara berkala dalam mengontrol perkembangan hama ini, karena tingginya tingkat perkembangan dan cepatnya laju pertumbuhan hama *A. hilaralis*.

Kata kunci: *Anthocephalus cadamba*, *Arthroschista hilaralis*, siklus hidup

INTRODUCTION

Arthroschista hilaralis (Lepidoptera: Pyralidae) is one of the defoliator pests which attack Jabon trees (*Anthocephalus cadamba*), causing a high degree of damage. These pests attacked Jabon trees in East Kalimantan and caused serious damage (Nair, 2000). Pribadi (2010) noted that these pests attacted Jabon stands in Riau, causing a damage (IS) level of 63%.

The pest attacks had absoulutely disrupted the plant growth. Junaedi and Pribadi (2011) recorded the attacks of *A. hilaralis* against 2-year-old Jabon stands in Riau Jabon which affected the growth of the trees by 46%. *A. hilaralis* which

attacked the leaves would disrupt the process of photosynthesis, inhibiting the plant growth. In addition, *A. hilaralis* attack can cause dieback and the formation of epicormic branchs (Nair, 2000).

Research on the life cycle of *A. hilaralis* has been conducted in India and Malaysia, but in Indonesia similar research has not been carried out before. The information related to the life cycle and life balance of *A. hilaralis* is badly required in determining appropriate pest management strategies for controlling *A. hilaralis* pest in Indonesia.

MATERIALS AND METHODS

Study site

Research was conducted in Juni -Juli 2014, in Entomology laboratory Faculty of Forestry, Bogor Agricultural University.

Materials and Research Tools

The materials used in this study were plastic containers, imago cage, brush, stereo microscope, optilab, *A. hilaralis* test insects, Jabon (*A. cadamba*) leaves, tissue paper, cotton and 10% liquid honey which was used as a food ingredient for imago.

Research Design and Data Analysis

The study was conducted in two stages, namely preparation of *A. hilaralis* insects and observation of their life cycles. The reparation was done by taking the *A. hilaralis* insect larvae which were found in Jabon trees in the field which were then reared in the laboratory until they became imagos and laid eggs. The eggs of the same age were collected and used for the observations of the life cycles from such stages as egg, larva, pupa, and imago.

Egg. Egg stadia were observed since the eggs were laid until they hatched into larvae instar I. The observations were focused on the shape, color, diameter, and length of the stage. The diameters were measured on the longest and widest parts.

Larva. Larva stadia were observed from the first to the last instar. The observations included the body color, length, and width as well as the stage length of each instar which was counted since it was out of the egg / molting until the next skin molting to occur.

Pupa. The observations of pupa stage were carried out when the pupa formed until it changed into imago. The observations of the pupae were focused on the shape, color, length of the stage, including the characteristics of male and female pupae. The length and width of the pupa were measured at the longest and widest parts.

Imago. The imago observations included the color, size, pre-oviposition period and life length of the imagos. The measurements of body length and wing span were done immediately after their death. The life cycles of *A. hilaralis* insects were counted from the early egg stage until they became imagos and started laying eggs.

The measurements of the length and width of eggs, larvae, and pupas were performed using a stereo microscope with 30 replicates at each stage. The imago measurements were conducted employing a ruler with as many as 10 pairs of imago replications. The data obtained in the study were analyzed descriptively.

RESULTS AND DISCUSSION

A. hilaralis developmental stages consist of egg, larva, pupa, and imago. *A. hilaralis* life cycle from egg stage to pre-oviposition took 25.1 days with an average stage of egg 2.7 days, larva12.6 days, pupa 6.9 days and pre-oviposition 2.9 days. The life development of *A. hilaralis* is presented in Table 1.

Tabel 1 Average of long stages and sizes of life development *Arthroschista hilaralis*

Life development	**Sizes of sample**	**Stage (day) ± sd**	**Length (mm) ± sd**	**Width (mm) ± sd**
Egg	30	2.7 ± 0.5	0.42 ± 0.03	0.39 ± 0.03
Larvae:				
a. Body				
First instar	30	2.5 ± 0.7	2.76 ± 0.89	0.33 ± 0.12
Second instar	30	2.2 ± 0.4	5.02 ± 1.34	0.60 ± 0.14
Thirth instar	30	2.3 ± 0.5	8.71 ± 1.90	1.00 ± 0.26
Fourth instar	30	2.2 ± 0.4	14.12 ± 3.30	1.62 ± 0.47
Fifth iInstar	30	3.4 ± 0.9	20.26 ± 3.00	2.51 ± 0.43
b. Head				
First instar	30		0.22 ± 0.08	0.28 ± 0.09
Second instar	30		0.41 ± 0.12	0.47 ± 0.13
Thirth instar	30		0.73 ± 0.28	0.82 ± 0.22
Fourth instar	30		1.29 ± 0.36	1.22 ± 0.26
Fifth iInstar	30		1.97 ± 0.16	1.82 ± 0.16
Pupa	30	6.9 ± 0.8	14.5 ± 0.73	3.01 ± 0.23
Male imago	10	4.0 ± 1.3	14.20 ± 0.92	
Wing span				27.85 ± 0.88
Female imago	10	6.9 ± 2.9	13.80 ± 0.63	
Wing span				28.30 ± 1.06
Praoviposisi	10	2.9 ± 0.7		
Life cycle of *A.hilaralis*		25.1		

Eggs. *A. hilaralis* eggs had an average length of 0.42 mm and width 0.39 mm, with a length range of 0.34 to 0.50 mm and width 0.34 to 0.47 mm (Fig. 1). *A. hilaralis* eggs were round and would hatch after 2-3 days, with an average hatching time of 2.7 days. In West Bengal (India), egg period lasted for 3-4 days (Thapa and Bhandari, 1976). When it was first laid, the egg was turbid white. The next day the egg would be red to indicate that the egg was ready to hatch (Fig. 2).

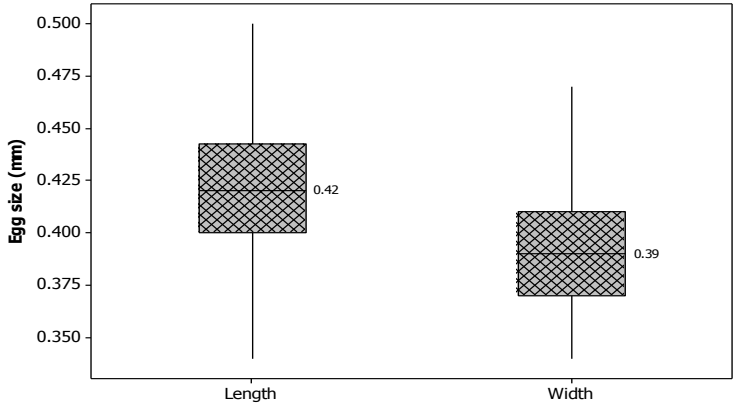

Figure 1. Eggs size of *Arthroschista hilaralis*: a) length; b) width

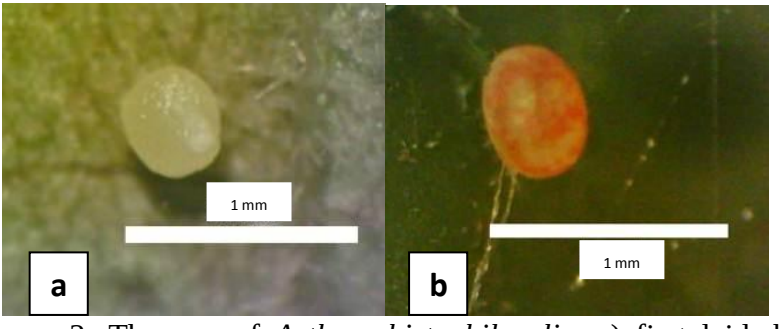

Figure 2. The egg of *Arthroschista hilaralis*: a) first laid; b) ready to hatch

Larvae. *A. hilaralis* larvae had cylindrical bodies with 3 pairs of true legs on the thorax and 4 pairs of false legs from the third to the sixth abdominal segment. Larval stage was the longest in the life development cycle of *A. hilaralis*. The average stage of *A. hilaralis* larvae was 12.6 days with a range of 11-15 days. In Sabah (Malaysia) the average stage of *A. hilaralis* larvae was 12-16 days and in West Bengal (India) 13-15 days (Table 2) (Thapa, 1970; Thapa and Bhandari, 1976). During the larval stage *A. hilaralis* experienced 4 times molting (ecdysis), resulting in 5 instar periods. Replacing the skin (molting) was a mechanism of the insect to take off its outer frame (exoskeleton) so that it can enlarge its size (Gullan and Cranston, 2000). Molting process is controlled by three hormones, that is, protorasicotropic hormone (PTTH), exdison, and juvenile hormone (JH).

Table 2 The difference of pre-mature sizes and long life of *Arthroschista hilaralis* in Malaysia, India and Indonesia

Stage	Sabah (Malaysia)[a]	West Bengal (India)[b]	Bogor (Indonesia)
Egge	-	3-4 days	2-3 days
Larvae	12-16 days	13-15 days	11-15 days
First instar larvae	4 days	2-3 days	2-4 days
Second instar larvae	2-3 days	2 days	2-3 days
Thirth instar larvae	2-3 days	2 days	2-3 days
Fourth instar larvae	2-3 days	2 days	2-3 days
Fifth instar larvae	4-6 days	3-4 days	2-5 days
Pupa	-	5-7 days	6-8 days
Imago	4-7 days	5-7 days	4-7 days

References: [a] Thapa (1970)
[b] Thapa dan Bhandari (1976)

A. hilaralis larvae that will undergo skin change were characterized by a change in their body color, becoming bleaker. In addition, they became less active in moving and eating. When the molting process was complete, the larvae remained still. The colors of the head and the body became brighter and clearer than before (Fig. 3). Some time after the larvae were back to be active eaters, the larval bodies became bigger and the body integument became harder. The old larval skin was usually not found as it was often eaten by the larvae themselves.

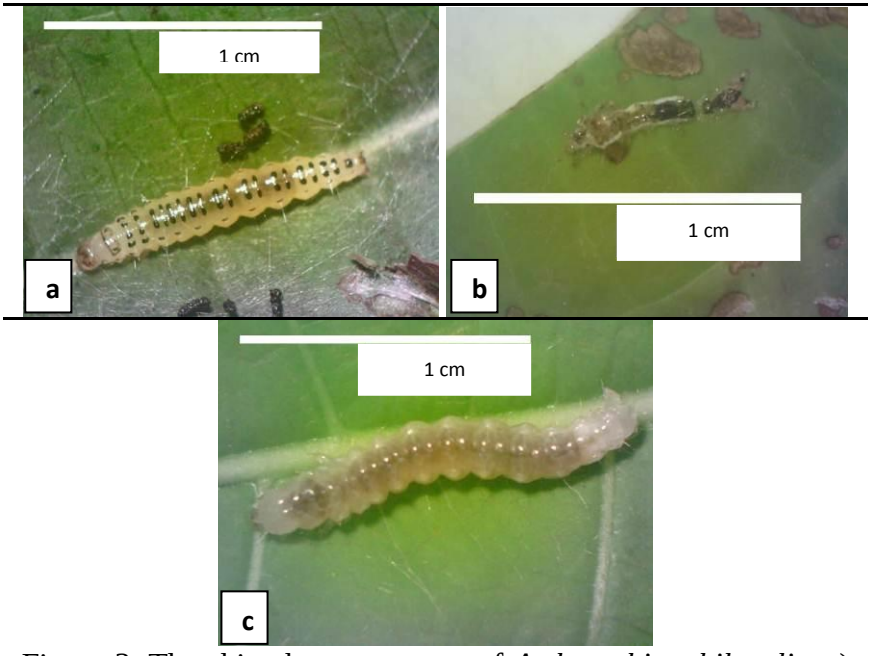

Figure 3. The skin change process of *Arthroschista hilaralis*: a) before molting; b) eksuvia; c) after molting

Instar I. The first instar larvae were counted from the time the eggs were hatched until the first skin underwent a molting process. This instar lasted for an average of 2.5 days with a range of 2-4 days. In Sabah (Malaysia), the larvae of the first instar lasted for 4 days and in West Bengal (India) 2-3 days (Table 2) (Thapa, 1970; Thapa and Bhandari, 1976). The average body length of *A. hilaralis* of the first instar was 2.76 mm and the width was 0.33 mm with an average length and width of the head was 0.22 mm and 0.28 mm respectively (Fig. 4).

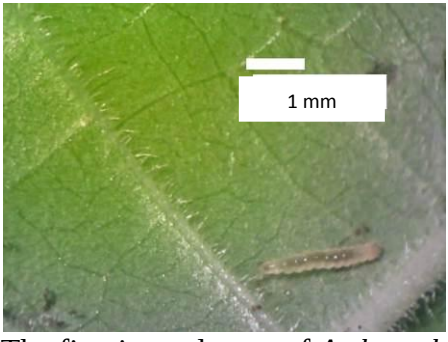

Figure 4. The first instar larvae of *Arthroschista hilaralis*

Instar II. The larvae of the second instar on average lasted for 2.2 days with a range of 2-3 days, but in Sabah (Malaysia) and in West Bengal (India) the second instar lasted for 2-3 days and 2 days tespectively (Table 2) (Thapa, 1970; Thapa and Bhandari 1976). In instar II the average body length of *A. hilaralis* was 5.02 mm and the width was 0.60 mm. The average length and width of the head was 0.41 mm and 0.47 mm respectively (Fig. 5).

Figure 5. The second instar larvae of *Arthroschista hilaralis*

Instar III. The third instar larvae on average lasted for 2.3 days with a range of 2-3 days. In Sabah (Malaysia) and in West Bengal (India) the third instar larvae lasted for 2-3 days and 2 days resepectively (Table 2) (Thapa, 1970; Thapa and Bhandari 1976). The average body length of *A. hilaralis* was 8.71 mm and the width was 1.00 mm with an average length and width of the head was 0.73 mm and 0.82 mm respectively (Fig. 6).

Figure 6. The third instar larvae of *Arthroschista hilaralis*

Instar IV. The fourth instar larvae on average lasted for 2.2 days with a range of 2-3 days. In Sabah (Malaysia) the fourth instar larvae lasted for 2-3 days and in West Bengal

(India) 2 days (Table 2) (Thapa, 1970; Thapa and Bhandari, 1976). On average the larval body length was 14.12 mm and the width was 1.62 mm. The average length and width of the head was1.29 mm and 1.22 mm (Fig 7).

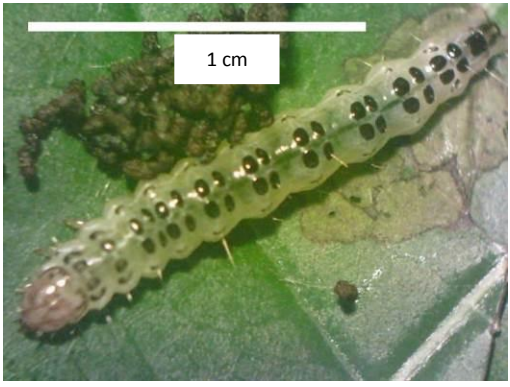

Figure 7. The fourth instar larvae of *Arthroschista hilaralis*

Instar V. The fifth instar larvae on average lasted for 3.4 days with a range of 2-5 days. In Sabah (Malaysia) the fourth instar larvae lasted for 4-6 days and in West Bengal (India) 3-4 days (Table 2) (Thapa, 1970; Thapa and Bhandari, 1976). In this instar the average larval body length of *A. hilaralis* was 20.26 mm and the width was 2.51 mm. The average length and width of the head was 1.97 mm and 1.82 mm (Fig. 8).

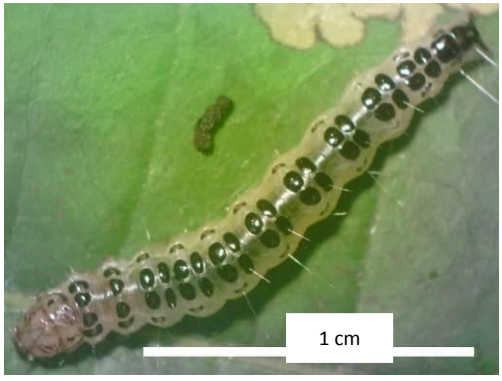

Figure 8. The fifth instar larvae of *Arthroschista hilaralis*

The distribution of the body lengths and widths of *A. hilaralis* larvae of 30 replicates in instars I to V was presented in Fig. 9 and Fig.10.

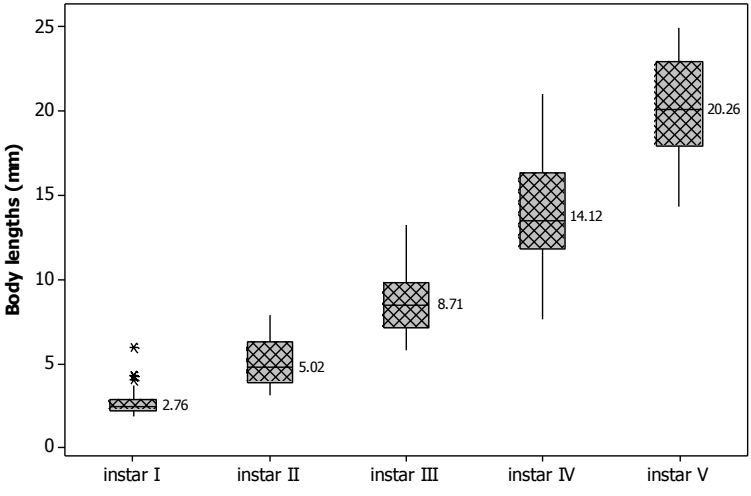

Figure 9. The distribution of the body lengths of *Arthroschista hilaralis* larvae in instars I to V

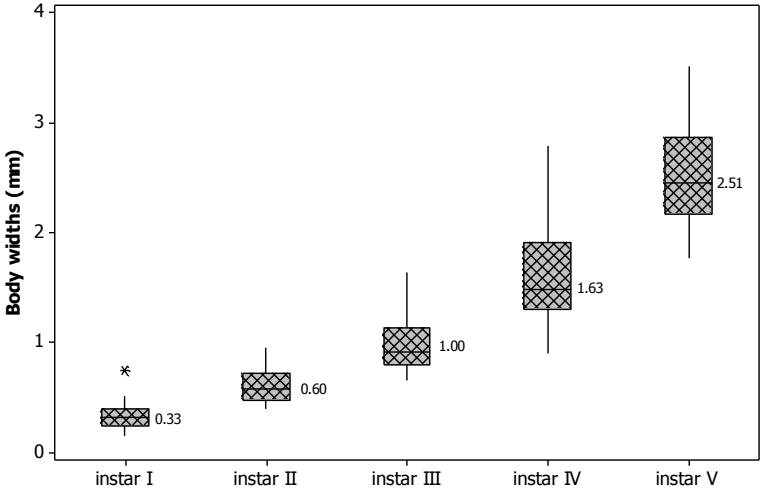

Figure 10. The distribution of the body widths of *Arthroschista hilaralis* larvae in instars I to V

Larval stadium was the most damaging stage of *A. hilaralis* pests. At this stage *A. hilaralis* attacked and disrupted the growth of Jabon trees. The larvae fed on the leaves of Jabon, disrupting the process of photosynthesis and inhibited the plant growth. *A. hilaralis* attacking young Jabon trees in the Jabon nursery could cause plant death. *A. hilaralis* larvae fed on the leaves of Jabon trees from the woven leaves they made. *A. hilaralis* larvae wove Jabon leaves using silk thread netting that came from their mouth. These interwoven leaves served as the refuge for *A. hilaralis* insects from enemies and unfavorable circumstances. In instars 1-2 the larvae of *A. hilaralis* only took the epidermal tissues of the leaves, and the folds of the woven leaves were not so tight (slightly open). In instars 3-5, *A. hilaralis* larvae ate all the leaves until all that remained was only the bones of leaves, and the woven folds of the leaves were already closed. The *A. hilaralis* pest control effort made during the larval stage using a contact insecticide will not be effective,

because the larvae of *A. hilaralis* are in the leaf folds. Systemic insecticides are more effective than contact insecticides. Systemic insecticides are absorbed and distributed by the plant tissue and for some time it will be stored in plant tissue in a certain amount and active as an insecticide. *A. hilaralis* larvae feeding on the leaves of Jabon will be exposed to systemic insecticides, even within the folds of the leaves.

Pupa. *A. hilaralis* pupa belongs to obtekta type. The candidates of antennas, mouth, wings and legs are attached to the body and cannot be separated. The color of *A. hilaralis* pupa was light brown with an average length of 14.50 mm and width 3.01 mm. The difference between male and female pupae is characterized by the presence of a bulge on the sternum of last abdominal segment in the female pupa, while the male pupa there is no bulge (Fig. 11). The pupal stage lasted for an average of 6.9 days with a range of 6-8 days (Table 2). In West Bengal (India), pupal period lasted for 5-7 days (Table 2) (Thapa and Bhandari, 1976). Pupa which is ready to be imago is characterized by a color change from light brown to greenish dark brown becomes (Fig. 12).

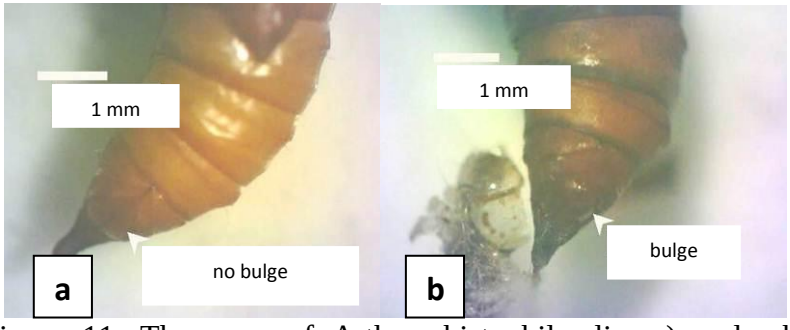

Figure 11. The pupa of Arthroschista hilaralis: a) male; b) female

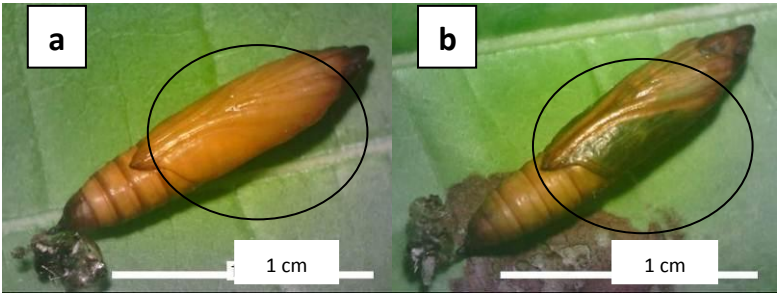

Figure 12. The pupa colour of *Arthroschista hilaralis*: a) First is light brown; b) ready to be imago is greenish dark brown

A. hilaralis larvae turned into pupae in the leaf folds they made. In the final instar, *A. hilaralis* larvae made leaf folds more adhesive than the folds made in the previous instar. In the pupal stage, *A. hilaralis* did not perform any activity other than metabolic activity, tissue change, and the formation of imago structure (Sihombing, 1999; Opler and Strawn, 2000).

Imago. *A. hilaralis* imago was bluish green with yellow orange along the wing costa (Fig. 13). Imago males and females have different body sizes that were not significantly different. The average body length of the male imago reached 14.20 mm with a wing span of 27.85 mm, while the body length of the female imago was 13.80 mm with a wing span of 28.30 mm (Table 1). The life span of male imagos was shorter than that of female imagos. The average length of the male imago life span was 4.0 days, whereas the female imago was 6.9 days (Table 1). Male imagos and female imagos can be distinguished from the shape of the tip of their abdomen. At the end of the male imago abdomen are covered with dense hairs and the color is black, while the female imago there are no hairs on the tip of the abdomen (Fig. 14). Imago gender in insect of Lepidoptera order can be distinguished from the color of the wings, body size, or

by seeing direct at the insect genitalia (based on the form of the abdomen) (Departemen Kehutanan, 1994).

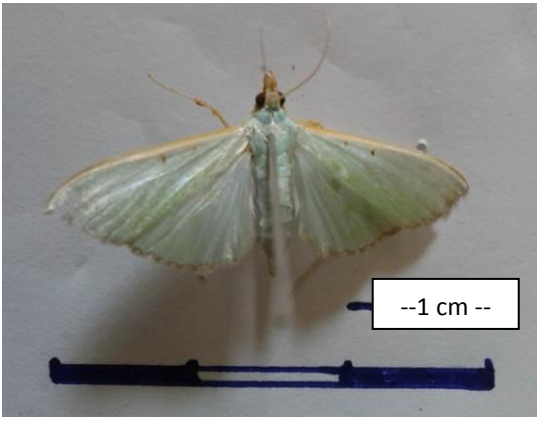

Figure 13. The imago of *Arthroschista hilaralis*

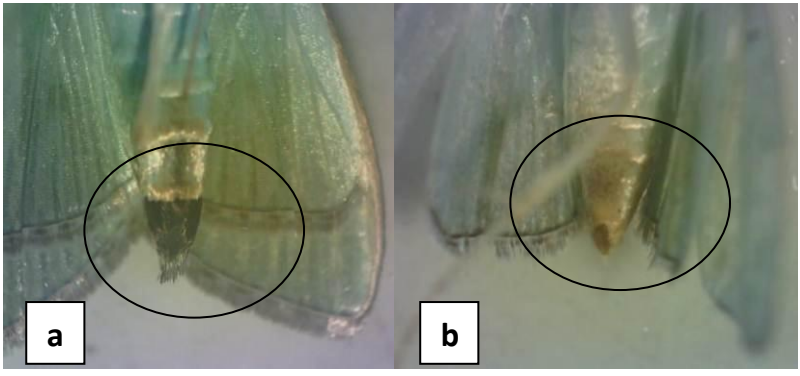

Figure 14. The tip of the abdomen of imago *Arthroschista hilaralis*: a) male; b) female

Imago *A. hilaralis* is active at night and attracted to light. *A. hilaralis* imago lays eggs at night in silk braid on the leaf surface made by the larvae of *A. hilaralis* one by one or in groups of two or three eggs. *A. hilaralis* pre-oviposition period lasted for an average of 2.9 days (Table 1) with a range of 2-4 days. The average number of eggs produced during its lifetime

was up to 129 grains, while in West Bengal (India) edult females of *A. hilaralis* only produced 60-70 eggs. The difference in the rate of the imago fecundity may be due to differences in environmental conditions or dietary factors. Jayaraj (1981) stated that the fecundity rate is determined by the stimulation of copulation, environmental conditions, genetic characteristics, and dietary factors. *A. hilaralis* control efforts undertaken in the imago stage can be done manually by using the behavior of adult *A. hilaralis* which are active at night and attracted to light. Control efforts can be done using light traps and water at night.

Based on this study, it was found that there were some differences between the life cycle of *A. hilaralis* in Malaysia (Thapa 1970) and that of *A. hilaralis* in India (Thapa and Bhandari, 1976) (Table 2). In addition to the differences in the life cycle, there were also differences in body size (Thapa and Bhandari, 1976) (Table 3).

Table 3. The differences of body sizes *Arthroschista hilaralis* in India and Indonesia

Description	Sizes (mm)	
	West Bengal (India) [a]	Bogor (Indonesia)
Length of egg	0.6-0.7	0.34-0.50
Wight of egg	0.4-0.5	0.34-0.47
Length of first instar larvae	4-6	2.76
Length of second instar larvae	8-10	5.02
Length of thirth instar larvae	16-18	8.71
Length of fourth instar larvae	20-22	14.12
Length of fifth instar larvae	25-27	20.26
Length of pupa	15	14.5
Wigth of pupa	4.5	3.01
Length Body of Imago	15	14

Reference: [a] Thapa dan Bhandari (1976)

Differences in the life cycles of each type of insects are determined by temperature, nutritional food, air humidity and so on during the development of insects (Wigglesworth, 1972). Mavi and Tupper (2004) explained that at high temperatures the activity of insects would be faster and more efficient, but long live insects would be reduced.

CONCLUSIONS

The life cycle of *A. hilaralis* on Jabon took 25.1 days, consisting of such stages as egg 2.7 days, larva 12.6 days, pupa 6.9 days and pre-oviposition imago 2.9 days. Periodic pest management action is needed to control the development of these *A. hilaralis* pests because of their high level of development and rapid rate of growth.

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