EFFECTS OF FOOD AVAILABILITY OF KEBEN (*Barringtonia asiatica kurtz*.) TO THE DEVELOPMENT OF LATE INSTARS OF *Attacus atlas* (L.) (LEPIDOPTERA: SATURNIIDAE) REARED OUTDOOR WITHOUT SCREEN

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INTRODUCTION

The atlas moth (*Attacus*) consists of 14 extant species and nine species of them live in Indonesia. *Attacus atlas* is the most widely distributed moth among of them. *A. atlas* is a polyphagous insect attacking more than 84 species of plant and considered as pest of several important crops (Peigler, 1989; Kalshoven, 1981). It was not until recently that we realized that the atlas moth produces usable silk. Non-mulberry silks, such as those obtained from *A. atlas* and *C. trifenestrata, Antheraea yamamai, A. pernyi,* and *A. mylitta,* endowed very high quality because these silks have numerous vacuoles, more porous, sleek feel, cool, anti allergic and bacteria (Akai, 1997). We have been succeeded to develop the silk into yarn, textile and other form of handy crafts. We also succeeded to build a foreign market for the product (Kuroda, 2000).

Today, cocoons needed to supply the atlas silk industry are harvested from wild. It is estimated that in the near future, if the industry grows up, the need to raise the moth will arise. Rearing of atlas moth must be conducted outdoor because ultra violet light is needed for proper cocooning (Situmorang, 1996). Our previous works showed that outdoor rearing of atlas is prone to predator and parasite attacks. The first instars larvae are more susceptible. The rearing facility for the first instars larvae must use screen to protect the larvae. In Yogyakarta Special Territory, *A. atlas* is frequently found on *keben* (*Barringtonia asiatica* Kurtz), soursop (*Annona muricata* L.), *gempol* (*Nauclea orientalis* L.), mahogany (*Swietenia mahagoni* Jacq), ylang-ylang (*Canangium odoratum*), avocado (*Persea americana* Mill), and *dadap* (*Erythrina lithosperma* Miq.). The female moth prefers keben to lay eggs. The larvae also show food preference to keben. These preferences correlate with a higher survivorship, fecundity, and better cocoon quality of larvae reared on the plant (Purwanto and Garjito, 2002; Purwanto, *et al*., 2002).

This **s**tudy was undertaken to investigate the effects of the availability of keben (*Barringtonia asiatica* Kurtz.) leaves to the development of the late instar of *Attacus atlas* (L.) larvae reared outdoor without screen.

MATERIALS AND METHODS

The study was conducted at Wild Silk Field Laboratory facility at Gadjah Mada University, Yogyakarta, Indonesia. To provide the larvae, wild collected cocoons were kept on strimin cage. After the emergence of the female adults, the female moths were taken outside the laboratory and mated to wild males. Eggs produced by the moth then sterilized using 4% of formalin and kept in petri dishes until hatching. Meanwhile, the female moths were screened for the presence of pebrine diseases. The larvae were reared under the screened keben plants until reaching its V^{th} instar.

A certain number of the V^{th} instar larvae were placed randomly on keben plants with five, 10, 15, 20, 25 and 25 leaves per larvae as determined from an exploratory test prior the experiment. The larvae were kept on its fodder plant until cocooning. The study used three replicate for five leaves per larvae treatment, five replicate for 10 leaves per larvae treatment, and six replicates for 15, 20, 25, 30 leaves per larvae treatments.

At seven days after cocooning, cocoons of atlas moth were harvested, and the total number of leaves consumed per plant was counted. Effect of food availability on the development of atlas moth was determined on the length of larval stadia, mortality rate during larval stage, on pupation, pupa, percentage of cocooning, total cocoon weight, pupal weight, empty cocoon weight, wingspan, adult weight and the length of regeneration time of keben plant fodder. Pests of atlas moth and keben as its plant fodder encountered during the course of study were recorded.

RESULTS AND DISCUSSION

As shown in Table 1. The development of *A. atlas* larvae reared on *B. asiatica* leaves were determined by the amount of the leaves available. The food availability affects the percentage of successful cocooning larvae, pupal weight, adult female weight and the length of regeneration of keben plants. On the treatment using five leaves per larvae, the survival rate of the V^{th} instar larvae to reach cocooning stage was the lowest $12.26 \pm 11.15\%$ with the empty cocoon weight as low as 1.17 ± 0.15g. Survival rate was increased as the amount of leaves available increased from 10 leaves per larvae to 25 leaves per larvae but the survival rate was not increased when the larvae fed with more than 25 leaves. The 25 leaves per larvae treatment resulted on $68.22 \pm 14.02\%$ survival rate, and 1.45 ± 0.33g of empty cocoon weight comparable to other treatments except for the five leaves per larvae treatment. The regeneration time of keben as plant fodder was corelated with the amount of leaves available for each larva. The shortest regeneration time was achieved on the 25 and 30 leaves per larvae treatments.

Food availability is a key factor for succesfull atlas moth rearing. Larval stadia is a critical period when the organism colecting matters and energy for its development and reproduction. During its last instar, atlas larvae consume a large portion of leaves to support the increasing need of energy. As much as 80.67% of total consumption of energy of atlas larvae occurs on the V^{th} and VI^{th} instars (Saragih, 1999). Food shortage will force the larvae to pupate early. Early pupation usually ended with a lower quality of cocoon and adult produced. Some the moth could not moult and eventually die during its efforts to pupate. The data showed the highest mortality rate

on the larval and pupal stadia of the five leaves per larvae treatment compared to the mortality of the other treament.

Food availability also indirectly affects mortality rate of atlas moth. The food depletion will lower its ability to survive from diseases, parasites and predators. It was shown that in *B. mori*, bacterial diseases caused by *Bacillus cereus* and *Serratia marcesens* were more prevalence on malnourished larvae (Yup-lian, 1991). Some of the dead atlas larvae on our observation were died due to pathogens infection.

Table 1. The effects of the availability of keben (*Barringtonia asiatica* Kurtz.) to the development of the late instar of atlas moth *Attacus atlas* (L.) larvae reared outdoor without screen

PARAMETERS	Treatments (amount of keben leaves / larvae)					
	5	10	15	20	25	30
Number of larvae reared	84	110	71	60	63	54
Length of larval stadia (days)	17.70±1.60 a	16.46±4.51 a	15.82±1.61 a	15.15±.0.64 a	16.29±2.02 a	15.02±2.59 a
Larval mortality (%)*	87.74±11.15 a	44.74±18.85 a	22.60±19.57 b	27.89±19.34 b	31.78±14.02 b	31.69±26.03 b
Failure to pupate (%)*	57.14 a	25.86 b	17.88 b	34.04 b	21.95 b	25.71 b
Pupal mortality (%)*	0 a	5.17 b	5.36 b	8.51 b	7.32 b	8.57 b
Cocooning percentage (%)*	12.26±11.15 a	55.26±18.85 b	77.40±19.57 b	72.11±19.34 b	68.22±14.02 b	68.31±26.03 b
Mean cocoon weight (g)*	6.89±2.42 a	8.38±2.41 b	9.43±2.53 b	9.10±1.86 b	8.47±1.72 b	9.74±2.29 b
Mean cocoon weight male (g)	7.88±3.90 a	7.99±2.08 a	7.78±2.02 a	8.13±1.49 a	8.61±2.06 a	9.11±0.96 a
Mean cocoon weight female(g)	9.12±0.78 a	9.99±2.56 a	11.05±2.19 a	11.36±2.32 a	10.20±2.23 a	10.69±2.49 a
Mean cocoon weight empty(g)*	1.17±.0.15 a	1.30±0.28 b	1.55±0.32 b	1.42±0.31 b	1.45±0.33 b	1.69±0.34 b
Mean cocoon weight empty male (g)	1.40±0.98 a	1.36±0.43 a	1.56±0.48 a	1.63±0.44 a	1.72±0.68 a	1.95±0.48 a
Mean cocoon weight empty female (g)	1.65±0.21 a	1.61±0.72 a	2.07±1.01 a	1.77±0.51 a	1.37±0.24 a	1.92±0.48 a
Mean Wingspan male (cm)*	17.50±2.55 a	18.83±1.31 ab	20.25±0.78 bc	19.86±1.48 bc	19.96±1.04 abc	20.87±0.64 c
Mean wingspan female (cm)	20.83±2.55 a	20.61±1.31 a	21.22±0.78 a	21.32±1.48 a	20.74±0.91 a	20.44±0.64 a
Mean weight adult (g)*	6.34+1.99 a	7.30+2.15 ab	7.69+2.21 b	7.77+1.72 b	7.30+1.77 ab	7.88+2.10 b
Mean weight adult male (g)	6.48±2.91 a	6.63±1.66 a	6.22±1.55 a	6.50±1.05 a	6.89±1.38 a	7.15±0.49 a
Mean weight adult female (g)*	7.46±0.58 a	8.38±1.84 b	8.98±1.18 b	9.59±1.82 b	8.83±1.99 b	8.77±2.00 b
Regeneration time of keben plant (day)*	>90 a	73.25+26.99 a	43.61+14.07 bc	57.5+24.54 ab	28.25+5.13 cd	28.2+4.19 cd

- Means within a column followed by the same letter were not significantly different at $P_{0,05}$

On heavily defoliated keben plants, the atlas larvae were more exposed to its predators and parasites. We observe the presence of predators such as Vespidae, Evanidae, Formicidae (*Solenopsis geminata* Fabricius and *Monomorium floricola*), Asilidae, and parasites such as, *Exorista sp*., *Xanthopimpla sp*.and a species belongs to Braconidae attacking the atlas moth. Moreover, in order to find another leaves or trees, the atlas larvae frequently crawl to lower part of the tree trunk, and it reaches the ground. This situation makes the larvae vulnerable to chicken

attacks. Although sometimes the red ant (*S. geminata*) went to the higher part of the tree to attack the atlas larvae, the most prevalent attacks were occurs when the larvae on the lower part of the trunk or on the ground. Furthermore, once the larvae reach the land, its leg will clogged with soil and the larva will eventually die.

Some caterpillars, grasshoppers and bugs such as *Parasa lepida*, *P. philepida*, *P. darmoides*, *Cheromettia sumatrensis*, *Valanga nigricornis*, and one member of Lymantriidae (1 species), Psychidae (3 species), Geometridae (2 species), Alydidae (1 species), and Coreidae (1 species) were attacking the plant fodder and thus suspected to compete with atlas rearing.

In India, it is a common practice to rear the first instars larvae of Indian tasar silkworm (*A. mylita*) under a screen. . The larvae will be transferred into field or forest, when reaching their last instars. The method could minimalized the larval mortality due to the attacks of pest and diseases and the cocoon production raised up to four times than tasar production reared on the hut or directly on the field from the first instar. The method also produces more consistent yield form year to year (Jolly *et al*., 1979). For atlas moth, since more than 80% of leaves are consumed by the last instars larvae, allocating a screened plant fodder only for the first instars larvae will reduce cost of investment. Provided that the amount of keben leaves is optimal, the mortality of the larvae as low as 27.89% is achievable on the out door rearing of atlas moth using keben as its plant fodder without screen.

REFERENCES

1. Akai, H. 1997. Recent Aspects of Wild Silkmoths and Silk Research. Presented on Seminar prospect of Cooperation between DIY Province-Kyoto. Center for Japan Study, Gadjah Mada University, Yogyakarta
2. Jolly, M.S., S.K. Sen, T.N. Sonwalkar, and G.K. Prasad. 1979. Non-mulberry Silk. FAO Agricultural Services Bulletin 29. Food and Agricultural Organization of the United Nation. Rome.
3. Kuroda, F. 2000. Outline of Indonesia wild silkworm development project (Practical use of golden cocoon and the world's biggest moth). *Int. J. Wild Silkmoth and Silk* 5, 85-89
4. Peigler, S.R., 1989. A Revision of the Indo-Australian Genus *Attacus*. The Lepidoptera Research Foundation Inc. Beverly Hills. California.
5. Purwanto, H., and T.A. Garjito. 2002. Eggs Deposition Preference of *Attacus atlas* (L.) (Lepidoptera: Saturniidae) on Several of Host Plants. Presented on The 4th International Conference on Wild Silkmoth 23-27 April 2002. Yogyakarta.
6. Purwanto, H., R. Widyarto, A. Wahyudi. 2002. Does Species of Parent's Host Plant of *Attacus atlas* (L.) (Lepidoptera: Saturniidae) has Effect on the Survivorship of Progeny when Reared on Other Plant Species? . Presented on The 4th International Conference on Wild Silkmoth 23-27 April 2002. Yogyakarta.
7. Saragih, O.V. 1999. Population Bioenergetic of *Attacus atlas* (L.) Larvae (Lepidoptera: Saturniidae). Faculty of Biology Gadjah Mada UniversityYogyakarta. Unpublished thesis.
8. Situmorang, J.1996. An Attempt to Produce *Attacus atlas* (L.) (Lepidoptera: Saturniidae) Using *Barringtonia* Leaves as Plant Fodder. *International Wild Silkmoth & Silk 2, 55-57.*
9. Yup-lian, Lu 1991. Silkworm Diseases. Translated by Liu Fu-an. Agricultural Services Bulletin 73/4. Food and Agriculture of the United Nation