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SHORT COMMUNICATION

Notes on Some Biological Aspects of *Arctornis riguata* Snellen (Lepidoptera: Lymantriidae)

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Arctornis riguata **Snellen is one of lymantriids which attacked a vast range of mango trees in Probolinggo at the beginning of 2011. About 1.2% mango trees from nine sub-districts have been defoliated by the larvae of this species. The larvae of this genus have been reported to forage at Anacardiacea as well; however, they have never been reported to forage at cultivated mango trees in Indonesia. Since there is no biological information of this species, thus, a study on some biological aspects of this species is needed. This study was conducted in the field as well as in the laboratory during 4 months (March-July 2011). The diagnostic characters of this species are black scale at dorsal antenna on both male and female and slightly setae particularly at the costal angle of valve on the male genitalia. Life span of this species is in the range of 30-37 days. This study also found four natural enemies of *A. riguata* i.e.: *Bleparipa* sp. (Diptera: Tachinidae), *Euagathis* sp. (Hymenoptera: Brachonidae), *Theronia* sp. (Hymenoptera: Ichneumonidae), and *Brachymeria lasus* (Hymenoptera: Chalcididae). Moreover, a single fungal pathogen of this species also was identified, i.e. *Isaria fumosorosea* Wize. Having these results, we considered that to control *A. riguata*, one need to conserve the native natural enemies by manipulating their environment.**

Key words: *Arctornis riguata*, biological aspects, mango, pathogen, Probolinggo

INTRODUCTION

Outbreak of lymantriid moths were reported in several locations in Indonesia, i.e. Probolinggo, Bali, Jakarta, Yogyakarta (Kulon Progo and Gunung Kidul), Lampung and others during the long rainy season in the early 2011. In term of the number of defoliated trees, the most phenomenal outbreak compare to other cases in Indonesia was in Probolinggo.

Arctornis riguata was found as the dominant species among the lymantriid moths that defoliated mango tree. This species has never been reported to seriously defoliate mango trees, even though mango trees is one the main host plants (Annacardiaceae) (Collenete 1948; Holloway 1999). In Probolinggo, about 14,813 of 1,227,879 mango trees (1.2 %) of nine sub-districts were seriously defoliated by the larvae of lymantriids (Department of Agriculture Probolinggo: unpublished data).

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The most phenomenal outbreak of lymantriids in Indonesia raised many questions not only on some biological aspects but also on the existence of this species, since there was no report on mango trees seriously defoliated by *A. riguata* previously. This study was conducted to elucidate some biological information of *A. riguata* including their life cycle and natural enemies. All information are needed to establish the strategy for controlling this new potential pest of mango trees. Moreover, by identifying their natural enemies and introducing them to control this species, we expect that the population of *A. riguata* is able to manage in the future.

MATERIALS AND METHODS

Site of Study. Study was conducted at heavy defoliated mango tress by the lymantriids larvae in Jatisari Village, Probolinggo (S 7°54.815´ E 113°10.140´) from March to July 2011. Other sites were also observed to fulfill the data especially on

the distribution of the host-plants (Annacardiaceae), i.e.: Wonokerto villages (Gunung Bromo, Tengger) (S 7°55.345´ E 112° 59.954´, Sukapura plantation state (Perhutani) (S 7° 55.478´ E 113°00.541´, Pasuruan (S 7°42.931´ E 113°03.900´ and Nongkojajar (Malang) (S 7°55.345´ E 112°49.347´).

Collecting the Adult Moths. Sampling of adult moths were conducted by using light traps equipped with a 160 watt mercury vapor light and a 2 x 2.5 m white screen. This method was a standard for moth collecting in tropical region as has been applied in the previous study (Holloway *et al*. 2001; Sutrisno 2008; Sutrisno 2010; Sutrisno 2012). The light trap was set up at the open area which was closed to mango trees. Males and females were collected by using a jar and then placed into net cages for transporting into laboratory. Larvae and pupae were collected by hand then were placed into net cages for rearing.

Rearing the Moths. A pair of male and female adult moth was placed in a net cage (40 x 20 cm) under room temperature in the Laboratory of Entomology, Division of Zoology, Research Center for Biology, Indonesian Institute of Sciences (LIPI), Cibinong and in the Laboratory of Pest and Diseases, Faculty of Agriculture, Gadjah Mada University. Within 1-2 nights, the female laid the eggs. Young leaves of mango were used to feed the larvae and replaced the leaves daily to keep the freshness. The length of each period of their life cycle was recorded.

Identification of the Adult. Adult of male and female were killed using ethyl acetate. Genitalia were removed from the abdomen and then placed on boiled 10% KOH for 15 minutes. Under a dissecting microscope the genitalia were dissected and then mounted into a euparal slide and dried up at 45 ^{o}C for 1-3 months (Sutrisno & Horak 2003; Sutrisno 2011; Sutrisno 2012). Male genitalia and the adults were identified based on Holloway (1999) and Collenette (1948).

Natural Enemies. Natural enemies were collected from the pupae collected from the field. All pupae that were infected by parasite and parasitoid were placed in plastic cages and then reared in Laboratory of Entomology, Zoological Division, Research Center for Biology, Cibinong. The natural enemies were identified by using Joseph *et al*. (1973), Gibson *et al*. (1997), Gauld (1984), Boucìk (1988), Goulet and Huber (1993).

Pathogen. Single spore isolation was conducted by isolate and determine fungal species infected *A. riguata* larvae. Five isolates were obtained from five samples of infected larvae of *A. riguata*. For identification, the DNA sequences that generated from ITS rDNA region of the culture were compared with the GenBank database.

RESULTS

Characteristic of *A. riguata.* Based on the adult collection the adult and the adult from the reared larvae, we found that almost 95% of the total population lymantriids that defoliated mango tree in Probolinggo during field observation was dominant by *A. riguata.* The other species of Lymnatriidae found were: *Lymantria beatrix*, *Orgya postica* and *Spharageidus orgincula*. A single species of Arctiidae (tiger moths) *Cyana* sp. was found only from sub-district Leces.

Males and females of *A. riguata* had same size approx. 20 mm on wingspan. Compared to other species, this species was moderately large with irregularly oriented broad scales on the forewing giving a mottled satiny effect. The black discal spot was very weak. At the spaces of the distal margin of the forewing showed faint grey triangles, and grey fringes at the hindwing. Unfortunately, all these characters were often lost during specimens handling thus difficult to distinguish with other six species of *Arctornis* reported in Java: *A. submarginata* Walker, *A. gigantea* Aurivillius, *A. marginalis* Walker, A. *phrika* Collenette, *A. micacea* Walker and *A. singaporensis* Strand (Collenette 1948; Holloway 1999). The other diagnostic of *A. riguata* was black outer scales of bipectinate antennae.

However, the male genitalia was the most appropriate for identification of *A. riguata* i.e. the distal to costal margin expanded and slightly setose, particularly at the costal angle, the harpe was down flexed at two thirds, broadening slightly beyond that point (Figure 1). This morph was differed with that of *A. submarginata* which was characterized by a well developed uncus (tongue-like) and an asymmetrically expanded apex of harpe.

Life Cycle. Within five days at the room temperature (32 ^{o}C), *A. riguata* eggs were hatched

Figure 1. Male genitalia of *A. riguata.*

into larvae that were very active during night. The development from 1st instar (approx. 0.5 cm in length) to the last instar (approx. 3 cm) took approx. 25 days. The pupation period of this species was very short, i.e. 4 days. The complete length on the life cycle of *A. riguata* was as follows: eggs = 5 ± 0 days, 1st Instar = 4.84 ± 5 days, 2nd Instar = 7.42 ± 8 days, 3rd Instar = 7.15 ± 9 days, 4th Instar = 6.31 ± 11 days, pupa = 4 ± 0 days (N = 19).

The life span of the adult was less than seven days. As other lymantriids, the proboscis of the adults of *A. riguata* is reduced or not develop, therefore this moth was not able to suck their foods for support its life. After emerging, male and female copulated at night and then female laid their eggs and they died within less than three days.

Level of Parasitized. The *A. riguata* pupae mostly fixed in its position, though not entirely immobile. The non-parasitized pupae showed green color, had a pair of white line vertically and uncover with hard, nut-like texture. The parasitized pupae was differ with the non-parasitized ones, due to the color was changed from green to become black/ brown in the parasitized pupae. The results of this study showed that the level of parasitized of the pupae was very high, i.e. range in 50-90% (N_1 = 76, N_2 = 58, N_3 = 63).

Natural Enemies. Based on the reared parasitized pupae in laboratory we found four species of parasites/parasitoids. i.e. *Blepariapa* sp. (Diptera: Tachinidae), *Euagathis* sp. (Hymenoptera: Brachonidae), *Theronia* sp. (Hymenoptera: Ichneumonidae), and *Brachymeria lasus* (Hymenoptera: Chalcididae). However, no record of the parasitism level of each species has been taken during the study. But, among them *B. lasus* was the most common. The characteristics of this species were a shiny black with a clear yellow apical part of the hind femur, and cream yellow with the entire inner half reddish black of hind tibia. The female laid a single egg in the host larva or pupae.

Pathogen. Morphological characteristics showed that the fungal isolated belong to the genus *Paecilomyces* or *Isaria*. The DNA sequences generated from ITS rDNA region determined that the sequences belong to the *Isaria fumosorosea* Wize (1904), by showing the sequence similarity 99% to *I. fumosorosea* (Syn. *Paecilomyces fumosoroseus* (Wize) A.H.S. Br. & G. Sm.

DISCUSSION

Outbreak of *A. riguata* is a new phenomenon. The larvae of this species was reported firstly to defoliate cultivated mango trees in Indonesia even though mango trees has been recorded since 1948 inhabit in Tengger (mountain Bromo), Probolinggo and mountain Gede Pangrango, West Java. At present, this species can be found in tropical forests which are distributed in Jawa, Sumatera dan Kalimantan at altitude 0-1100 meter above sea level (Collenette 1948; Holloway 1999).

In Probolinggo, *Mangifera* spp. distribute continuously from low altitude in Probolinggo city (<10 m above sea level) to high altitude in Sukapura (at 900 m above sea level, below Tengger). Therefore, it is not surprising that *A. riguata* that has been recorded to inhabit Tengger in 1948 (Collenette 1948) and currently defoliated mango trees in Probolinggo. The distance between those two habitats is quite close and the host plants also grow abundance in between these two places. However, our study showed that no single individual of *A. riguata* can be found in Sukapura plantation state (Perhutani) and Wonokerto villages (Gunung Bromo, Tengger).

Heavy defoliation on mango by lepidopterous larvae will inhabit the flowering process as has been reported by Schreiner and Nafus (1991). They studied on mango trees which are damaged by mango shoot caterpillar, *Penicillaria jocosatrix* Guenee. Significant negative association was showed between severity of damage to a shoot and interval until new shoot initiation. Shoots that flushed out of synchrony with the majority suffered heavier caterpillar damage. Untreated trees compensated the damage by producing additional flushes, but at the end of one year they still had one-third less foliage than treated trees. At the end of one year, trees that had a leaf area < 4-5 m^2 per 25 shoots did not flower in response to an inducer. So, it is very important to manage the defoliation of the shoot by the larvae of *A. riguata* does not occur twice continuously.

The most important natural enemies among the four species recorded in this study is *Brachymeria lasus*. This species is known as a polyphagus pupal parasitoid with a host range of Lepidoptera, Diptera and Hymenoptera (Mao & Kunimi 1994). It was reported that this species is one of candidates of a biological control agents of several groups of Lepidoptera (more over 20 families of Lepidoptera including Pyralidae, Lycaenidae, Lymantriidae, and Tortricidae) (Towell & Coppel 1987; Mao & Kunimi 1994). This parasitoid was reported able to parasitize *Homona marganina* (Lepidoptera: Tortricidae) up to 55.1% (Mao & Kunimi 1994). This study also showed that the level of parasitism of this species on *A. riguata* was high (> 50%).

Our report was the first finding of *I. fumosorosea* on *A. riguata* in Indonesia. Tzean *et al*. (1997) reported that several species of the genus *Isaria* capable of inhabiting a variety of insect hosts, and some were host-specific. In agricultural habitats, the association of *Isaria* and other entomopathogen such as *Beauveria*, *Metarhizium*, *Aschersonia*, *Entomophthora Paecilomyces*, and *Neozygites* with varied insect- or mite hosts are common. These fungal pathogens, except *Aschersonia* and entomophthoraleans, usually show less host specificity, but often cause epidemics in a particular host (Samson *et al*. 1988). The current *I. fumosorosea* isolate has been examined to produce chitinase enzyme. The death of the host is usually led by the destruction of the host tissue and will be followed by the formation of sporulating structures on the hosts to release the conidia and thus initiate a new infection cycle.

Based on these results, we proposed two methods to reduce the population of *A. riguata*; first by collecting the emerged parasite/parasitoid from the larvae and or pupae that kept in mosquito net. This simple technique can be applied not only for *A. riguata* but also for any other insect pests.

One can also use the natural enemies such as *B. lasus*, *Oechopilla smaradigna*. Naturally, the first species can be conserved in the area by manipulating their environment i.e. planting several local flowering shrubs that provide nutrition for the adult. If the nutrition for the adults is available, they will able to control the population of *A. riguata*. Conserving the predator *O. smaradigna* is one the most effective to control the larvae as has been reported by Lim *et al*. (2008). He reported that this weaver ant was able to control the *Hypsipilla robusta* (shoot borers of Mahagony). The main problem with this weaver ant is that there is a huge demand of the larvae of this ant (Sribandit *et al*. 2008). Thus, it needs the public awareness to conserve this species, especially in the mango plantation.

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