

THE ATTACK of *Rastrococcus* sp. (HEMIPTERA: PSEUDOCOCCIDAE) ON *Dysoxylum mollissimum* Blume IN CAMPUS FOREST OF BENGKULU UNIVERSITY

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ABSTRACT

The attack of Rastrococcus sp. (Hemiptera: pseudococcidae) on Dysoxylum mollissimum Blume in campus forest of Bengkulu University. *Dysoxylum mollissimum* is a commodity that is widely used as carpentry wood and furniture in Bengkulu. *Rastrococcus* sp. is one of the pests of *D. mollissimum*. The purpose of this study was to evaluate the attack of *Rastrococcus* sp. on saplings, poles and trees *D. mollissimum* in the campus forest of Bengkulu University. The study was conducted with a purposive sampling survey method. The observational variables were symptoms and the rate of attack of *Rastrococcus* sp. at various stages of growth, the host range, and the identification of natural enemies of *Rastrococcus* sp. The results showed that *Rastrococcus* sp. was able to attack *D. mollissimum* at all growing stages, namely sapling, pole and tree. The highest number of *Rastrococcus* sp. population was observed in the pole phase (35.4 ± 6.46 individuals), then the tree phase (34.9 ± 20.38 individuals), and saplings (26.3 ± 5.12 individuals). The *Rastrococcus* sp. was commonly found in the lower leaves. *Scymnus* sp. (Coleoptera: Coccinellidae) and Acarina (mites) were found as predator of the mealybug. This information is expected to be a reference in developing control strategies of *Rastrococcus* sp. especially on *D. mollissimum*.

Key words: attack, *Dysoxylum mollissimum*, growth phase, natural enemy, *Rastrococcus* sp.

INTRODUCTION

Dysoxylum mollissimum Blume is a fast growing tree (Ishiguri *et al.*, 2016) that is a superior type of local timber in Bengkulu Province which famous for its quality and durability. The wood of *D. mollissimum* has a level B resistance to termite, thus, this tree has a sufficient capability to survive from the assault of termite (Nuriyatin *et al.*, 2003). The wood is cut into lumber for used in construction and furniture. As a result, the tree is widely planted and holds commodity value in Bengkulu (Depari *et al.*, 2013a; Premono & Lestari, 2014). Development of *D. mollissimum* cultivation is a solution to meet the needs of wood for the people in Bengkulu. Depari *et al.* (2013b), reported that *D. mollissimum* is traded in various sizes of sorts in wood depots in the city of Bengkulu.

The *D. mollissimum* cultivation in a vast expanse in monoculture resulted in plants susceptible to pests. Based on observations in the campus forests of Bengkulu University, *Rastrococcus* sp. (Hemiptera: Pseudococcidae) is one of the important pests attacking

D. mollissimum. These mealybugs cause plant growth inhibition from mild to severe. The *R. invadens*, one of *Rastrococcus* species, has wide host consisting 45 species from 22 families including forest trees, vegetables, shade trees, fruit trees and ornamental plants (Tanga *et al.*, 2016). The attack of *Rastrococcus* sp. can harm because it sucks the liquid nutrients from plants. The *R. invadens* could spread quickly invading eastern regions of West and Central Africa causing 50–90% damage to mangoes; moreover it also brings social and cultural problems (Tanga, 2012).

Mealybug populations in a plant habitat were influenced by host diversity, habitat conditions and seasonality (Geiger & Daane, 2001; Walton *et al.*, 2004). In addition, the mealybug populations in plants vary between the attacked plant parts (Khan *et al.*, 1998). However, information about *Rastrococcus* sp. in *D. mollissimum* has never been reported. Considering this fact, it needs to perform research about the attack of *Rastrococcus* sp. on *D. mollissimum*, especially in campus forest of Bengkulu University. The purpose of this study was to evaluate the attack of *Rastrococcus*

sp. on *D. mollissimum* in the campus forest of Bengkulu University.

MATERIALS AND METHODS

Research Site. This research was conducted at campus forest of Bengkulu University (-3°45'30,38101"S 102°16'20,60735"E, altitude: 35.6 m) Kandang Limun, Muara Bangkahulu, Bengkulu. Identification of *Rastrococcus* sp. and its natural enemy was done in April–November 2019 at Plant Protection Laboratory, Department of Plant Protection, Faculty of Agriculture, Bengkulu University.

Sample Collection. The sample was collected at campus forest of Bengkulu University, Kandang Limun, Muara Bangkahulu, Bengkulu in April 2019. The *D. mollissimum* has tree growing phases: sapling, pole and tree. On each phase, every parts of the trees was observed. The *D. mollissimum* leaf collected for *Rastrococcus* sp. observation was selected based on its position within the canopy (upper, lower, and middle). The observation area was one ha covering each phases of plant growth. Ten plant samples were randomly selected in each of the observation area. The *D. mollissimum* growing stages based on Septiawan *et al.* (2017) are: seedling: small tree from sprouts to height < 1,5 m, sapling: small tree that reach ≥ 1.5 m in height or diameter at breast height (DBH) < 10 cm, pole: sapling that has DBH around 10–20 cm, and tree: mature tree that has DBH ≥ 20 cm.

The *Rastrococcus* sp. samples taken from plants were put into plastic bottles containing 70% alcohol and observed under a stereo microscope. Calculation of *Rastrococcus* sp. population was done in the laboratory by counting the total population in all parts of the plant starting from the stem, branches and leaves of the plant.

Symptoms Observation. Symptoms observation was conducted by direct observation on selected trees for the presence of *Rastrococcus* sp. on each part of the tree (stems, branches and leaves). The observed symptoms then stored as a picture using a digital camera.

***Rastrococcus* sp. Identification.** The observed *Rastrococcus* sp. was identified by the identification keys of Williams & Watson (1988), Cox (1989), Williams & de Willink (1992), and Williams (2004).

Variety of *Rastrococcus* sp. Population at Each Tree Growing Stage. Samples at each growing stage of *D. mollissimum* were ten trees. The observation variable

was *Rastrococcus* sp. attack at each growing stage of *D. mollissimum*. The presence of *Rastrococcus* sp. on *D. mollissimum* was observed in all parts of the tree, i.e. on the trunk, branches, and leaves. The *Rastrococcus* sp. were photographed with a digital camera and the population of *Rastrococcus* sp. infested the plant parts were counted in the laboratory.

Host Range. Habitat and plant characteristics around *D. mollissimum* trees were also observed i.e. parts of leaves, branches and stems that were attacked by *Rastrococcus* sp.. Plants around *D. mollissimum* attacked by *Rastrococcus* sp. were also randomly observed. The *Rastrococcus* sp. which were found in the surrounding plants were brought to laboratory for further observation. If the same *Rastrococcus* sp. attacking *D. mollissimum* were found on the surrounding plants, the plants will be categorized as a host. All samples were taken to the laboratory, then transferred to a plastic container covered with gauze.

Inventory of Natural Enemies in the Field. The presence of the natural enemies of *Rastrococcus* sp. was examined by performing direct observation on the *D. mollissimum*. The natural enemies were then collected and brought to the laboratory for further identification. The identity and total natural enemies which were found was recorded.

Data Analysis. *Rastrococcus* sp. infestation was calculated by counting the number of individuals found at the growth rate and affected plant parts. The data obtained from calculation of *Rastrococcus* sp. population were analyzed using analysis of variance (ANOVA) and Duncan test at level of 5%.

RESULTS AND DISCUSSION

The attack of *Rastrococcus* sp. can be initiated by the yellowing of *D. mollissimum* leaves. The cell fluid of *D. mollissimum* was suctioned by this mealybugs. The leaves were also overgrown with sooty mold resulted from the secretion of *Rastrococcus* sp. The severe attacks on the shoots will cause in dried shoots which can inhibit growth and development of the branches (Figure 1), while straight wood is needed in this grow of the wood. The sooty mold can block the sun light causing inhibition of photosynthesis process and decrease the tree productivity. The results of this study was in line with Tanga (2012), stated that the

attack of *R. iceryoides* causes defoliation, inhibit flower and fruit formation.

Losses due to *Rastrococcus* sp. infestation on pineapple have been reported in Brazil as high as 50% (Khan *et al.*, 1998). *R. invadens* caused 50–90% loss in mango (Tanga, 2012). In addition, mealy bug pests are vectors of some plant diseases. *Dysmicoccus brevipes* is a vector of PMWaV virus (Pineapple Mealybug Wilt associated Virus). *Planococcus minor* is a vector PYMV (Piper Yellow Mottle Virus) which reduces pepper production by 30–40% (Sihombing 2005). *P. solenopsis* attacked cotton caused a yield reduction of 44% in Pakistan (Dhawan *et al.*, 2007). Ivakdalam (2010) reported that the *P. marginatus* attack on papaya can reduce fruit production in Bogor district by 58% and increase production costs by 84%.

Rastrococcus sp. attack *D. mollissimum*, live and breed in all growth stages of the tree. The observation result showed that of the spread of *Rastrococcus* sp. on the plant parts of *D. mollissimum* were presented in Figure 2. The result showed that *Rastrococcus* sp. can

be found in all parts of the *D. mollissimum* plant. Based on this information it can be seen that the *Rastrococcus* sp. can be found in all phases of the growth of *D. mollissimum*. *Rastrococcus* sp. use *D. mollissimum* as a shelter and food source. Waterhouse (1998) reported that *Rastrococcus* sp. can attack plant parts such as roots, leaves, stems and fruits. *Rastrococcus* sp. that live on plant seeds, can act as a source of infection in the field.

Generally, the highest number of population of *Rastrococcus* sp. was in the pole phase, precisely at the lower leaves (35.4 ± 6.46 individuals), then the tree phase (34.9 ± 20.38 individuals) and saplings (26.3 ± 5.12 individuals) (Table 1). *Rastrococcus* sp. preferred to live on the leaves *D. mollissimum* compared to the other plant parts because the leaves were softer than the bark or roots, so that *Rastrococcus* sp. could stabbed their stiletts easier to suck up the liquid from the leaves *D. mollissimum*. The results of this study were in line with the research reported previously (Khan *et al.*, 1998; Sether & Hu, 2002), which stated that the *D. brevipes*

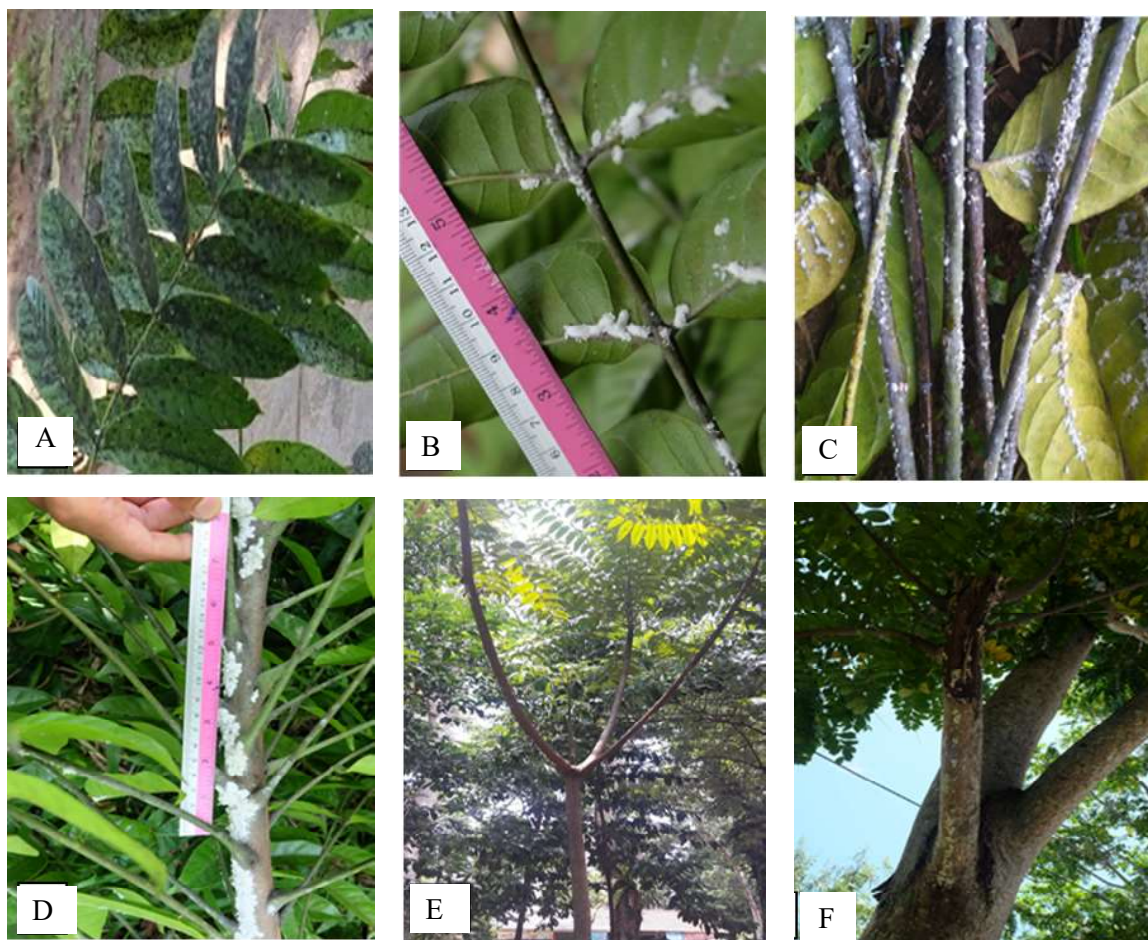


Figure 1. The attacking of *Rastrococcus* sp. on various growth stages of *D. mollissimum* and the attacked plant parts. (A) Sooty molds on attacked leaf; (B), (C) Leaves; (D) Sapling; (E) Pole; (F) Tree.

are found mostly on the leaves. The *Rastrococcus* sp. population attacks on saplings, poles and trees of *D. mollissimum* was presented in Figure 2.

The results of this study indicated that the leaves are more suitable for the life of *Rastrococcus* sp. It can be seen from the population of *Rastrococcus* sp. that are more numerous in the leaves, especially in the older (lower) leaves. The water content, glucose, and nitrogen in the leaves are higher than those in the bark or roots (Mamahit, 2009). Moreover, the nitrogen content was sufficiently available in the older leaves so that the *Rastrococcus* sp. had better access for food source. Schoonhoven *et al.* (1995) stated that giving the high nitrogen content to insects helps insects eat more efficiently than low nitrogen content. *Rastrococcus* sp. preferred to live on the underside of leaves because they would be protected from exposure of wind, rain, and natural enemy. Mealybug populations at a crop location are influenced by host diversity, habitat conditions and seasonality (Geiger & Daane, 2001; Walton *et al.*, 2004). In addition, the mealybug population in different plants

depends on the part of the plant attacked (Khan *et al.* 1998) and air temperature (Chong *et al.*, 2008). According to Gruenhagen & Backus (1999), the population abundance and spread of pests in plants are very important to learn so that further knowing various things about its ecology. This is needed in an effort to prevent broader developments and the control efforts (Leksono *et al.*, 2005).

The rate of *Rastrococcus* sp. attack on *D. mollissimum* trees at various growth stages was presented in Table 1. The results of the analysis of variance showed a difference in the rate of *Rastrococcus* sp. attack on the *D. mollissimum* at each growth stage. The rate of *Rastrococcus* sp. attack on *D. mollissimum* was higher in the pole phase compared to the tree and sapling phases. This result was in line with Asbani (2005). The high level of *Rastrococcus* sp. attack was related to the high *Rastrococcus* sp. population at the location, the diversity of host plants, the suitability of various physical and environmental factors for the development of the *Rastrococcus* sp..

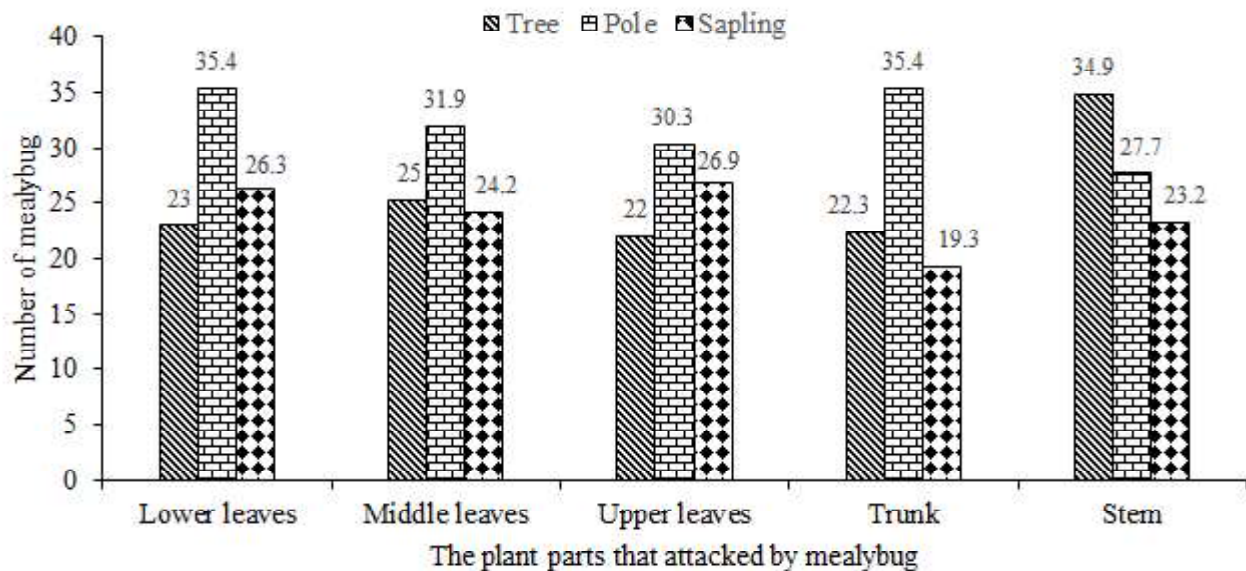


Figure 2. Number of *Rastrococcus* sp. on each parts of the *D. mollissimum*.

Table 1. The population of *Rastrococcus* sp. on various growth stages of *D. mollissimum*

No	Plant parts	Tree	Pole	Sapling
		Number of <i>Rastrococcus</i> sp (\bar{x}) \pm SD		
1	Lower leaves	34.90 \pm 20.38 a	35.40 \pm 6.46 b	26.30 \pm 5.12 a
2	Middle leaves	25.30 \pm 9.49 a	31.90 \pm 12.46 a	24.20 \pm 10.20 a
3	Upper leaves	22.00 \pm 9.69 a	30.30 \pm 10.58 a	26.40 \pm 9.32 a
4	Trunk	22.30 \pm 10.37 a	35.40 \pm 7.27 b	19.30 \pm 7.27 a
5	Stem	23.00 \pm 6.63 a	27.70 \pm 14.12 a	23.20 \pm 7.25 a

The number followed by same alphabet is not significantly different (Duncan test, $\alpha = 5\%$).

The location of *D. mollissimum* in the sapling stage were surrounded by Hibiscus flowers and durian which are also hosts from the *Rastrococcus* sp., so that the population of *Rastrococcus* sp. was higher due to the availability of host plants, and the spread of *Rastrococcus* sp. can occur rapidly. In Indonesia, mealybug has reported to attack various types of hosts including mangosteen (*Garcinia mangostana* L.), soursop (*Annona muricata* L.), guava (*Psidium guajava* L.), rambutan (*Nephelium lappaceum* L.), durian (*Durio zibetinus* L.), and duku (*Lansium domesticum* Corr.) (Williams, 2004).

The spread of *Rastrococcus* sp. could be affected by wind carried by seeds, humans, birds and other insects. The highly populated *Rastrococcus* sp. and its nature as a polyphage have the potential to spread very quickly. Besides that, its biological properties can damage plants by sucking the fluids and releasing toxins, causing chlorosis, dwarf, leaf malformation, and young leaves fall. In addition, the exudates produced by *Rastrococcus* sp. in the form of honey dew cause plant death (Figure 1). Thus, *Rastrococcus* sp. potentially cause high economic disadvantage.

The *D. mollissimum* bark and main stem contain chemical compounds, such as steroid, triterpenes, coumarin, lignans, flavonoids, fraxetin, scopoletin and lupeol (Almeida *et al.*, 2002). According to Schoonhoven

et al. (2005), the plants also produce secondary metabolites which play a role in the mechanism of interaction between the *Rastrococcus* sp. and its host. Preference or acceptance of the host in insects is influenced by the quality of macro and micro nutrients, volatile compounds, secondary metabolites, phenology, hardness, and plant resistance mechanisms (Shahid *et al.*, 2013).

The natural enemies of *Rastrococcus* sp. were found in the field including predators of the order Coleoptera: Coccinellidae i.e. *Scymnus* sp. (Table 2), and Acarina (mites) (Figure 3). According to Sartiami *et al.* (2009), the natural enemies of *Rastrococcus* sp. are predators from the Diptera order, Syrphidae family; the Coleoptera order, Coccinellidae family, and the Neuroptera order, Chrysopidae family. The parasitoid group found was the Hymenoptera order from the Encyrtidae, Braconidae, Scelionidae, and Eulophidae families. *Rastrococcus* sp. predators that have been found in the Bogor and Sukabumi regions are *Scymnus* sp., *Curinus coeruleus*, *Chilocorus* sp. and *Cryptolaemus montrouzieri*. In addition, fungi are also found as entomopathogen for papaya *Rastrococcus* sp.. The fungus found to infect papaya *Rastrococcus* sp. was the member of Entomophthorales order (Sartiami *et al.*, 2009).

Table 2. The population of *Rastrococcus* sp. natural enemy, *Scymnus* sp. larvae, on various growing stages of *D. mollissimum*

No	Plant parts	Tree (n=10)	Pole (n=10)	Sapling (n=10)
		Number of <i>Scymnus</i> sp. larvae (\bar{x})		
1	Lower leaves	2	1	1
2	Middle leaves	1	1	1
3	Upper leaves	2	1	1
4	Trunk	2	1	1
5	Stem	2	2	0

n: Number of sample plants.

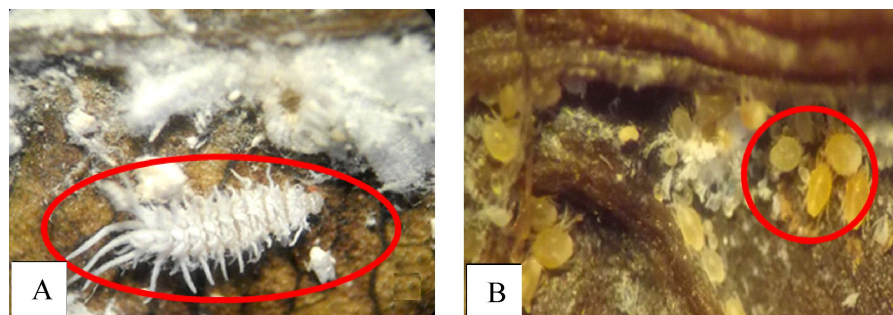


Figure 3. The *Rastrococcus* sp. predators. (A) *Scymnus* sp. eating the *Rastrococcus* sp.; (B) Acarina (Mites).

The number of predators found in the field was low compared to the population of *Rastrococcus* sp. observed on the *D. mollissimum* (Table 2), thus it not able to reduce the population of *Rastrococcus* sp.. This situation was influenced by the presence of ants in these plants. The reciprocal relationship between ants and *Rastrococcus* sp. species is related to honey dew produced by *Rastrococcus* sp., which is an important food source for ants. The ants would eventually disrupt or kill parasitoids and predators (Tanga, 2012). *Anagyrus pseudococci* (Hymenoptera: Encyrtidae) is a parasitoid of *R. iceryoides*. The activity of this parasitoid is disrupted by ants *Anoplolepis steingroeveri* Forel (Hymenoptera: Formicidae), *Crematogaster peringueyi* Emery (Hymenoptera: Formicidae) and *Linepithema (Maymen)* (Mgocheki & Addison, 2009). The percentage of parasitism of *R. iceryoides* by *A. pseudococci* was significantly higher without the presence of ants ($86.6 \pm 1.27\%$) than ants were presence ($51.4 \pm 4.13\%$). Ants *Oecophylla longinoda* provide protection to *R. iceryoides* against parasitoids and predators. The presence of *O. longinoda* has a detrimental effect on the abundance, reproductive success and oviposition strategies of female *A. pseudococci* parasitoids, which may be a limiting factor in the field conditions (Tanga et al., 2016).

CONCLUSION

The highest population of *Rastrococcus* sp. were on the pole stage of *D. mollissimum*, reaching (35.4 ± 6.46 individuals), then the tree stage reaching (34.9 ± 20.38 individuals) and saplings (26.3 ± 5.12 individuals). The majority of the *Rastrococcus* sp. were found in the lower leaves. *Scymnus* sp. (Coleoptera: Coccinellidae) and Acarina (Mites) were found as predator of the mealybug. This information is expected to be a reference in developing strategies to control *Rastrococcus* sp. on *D. mollissimum* plants.

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