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Potential Natural Enemy of The Pest *Brontispa longissima* Gestro on Coconut Plants in North Minahasa District

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Abstract

Inhibiting factors in efforts to increase coconut production in Indonesia include pest and disease attacks. One type of pest that attacks coconut plants is *Brontispa longissima* Getro. The coconut leaf beetle *Brontispa longissima* is one of the main pests that attacks almost all stages of coconut growth and can cause up to 40% leaf damage. Damage to the leaves will result in a loss of coconut production of up to 50%. The research aims to determine the potential natural enemies of the pest *Brontispa longissima*. The research was conducted in 3 villages in North Minahasa Regency. The population of each stage of development of *Brontispa longissima* varies with the average population of larval development being 43.68% followed by pupae 24.24%, imago 16.17% and the lowest population namely eggs 15.91%, with the natural enemy found being the pupal parasitoid Tetrastichus brontispae (*Hymenoptera: Eulophidae*), the entomopathogenic fungus *Metarhizium anisopliae*, and predators cocopet Celisoches morio (*Dermaptera: Celisochidae*). The most common natural enemy found is the *cocopet C morio*.

Keywords: *Brontispa longissima*, *cocopet C morio*, Natural Enemy, *Metarhizium anisopliae*, parasitoid

1. Introduction

Coconut (*Cocos nucifera* L.) is a highly important crop from both economic and socio-cultural perspectives. Due to the economic value of all parts of the coconut tree, it has been given the prestigious title of "The Tree of Life" (Mardiatmoko & Arianti, 2018).

One of the major constraints in increasing coconut production in Indonesia is the attack of pests and diseases. One of the significant pests affecting coconut plants is *Brontispa longissima* Gestro (Coleoptera: Chrysomelidae). *B. longissima* attacks both young, non-productive plants and mature, productive ones (Lumentut & Indrawanto, 2013). Its infestation hampers the growth of young plants and, in severe cases, can lead to plant mortality (Alouw, 2007).

The coconut leaf beetle (*Brontispa longissima*) is a major pest that attacks almost all growth stages of the coconut plant, causing leaf damage of up to 40%. Leaf damage significantly reduces coconut production, with potential yield losses reaching 50% (DITJENBUN, 2017).

Biological control is recognized as an effective method for managing key pests affecting coconut plants (Rahmawati, 2019). Several biological control agents have been reported as potential natural enemies of *B. longissima*, including the parasitoid *Tetrastichus brontispae* Ferr., the predatory beetle *Celisoches morio* Cocopet, and the entomopathogenic fungus *Metarhizium anisopliae* (Lumentut et al., 2018).

B. longissima attacks both young and mature coconut plants, inhibiting growth in young plants and, in severe cases, causing plant death. According to Hosang (2021), the biology of *B. longissima* includes dark brown eggs laid in clusters of up to 120 by the female imago. The larval stage consists of five instars, appearing white yellowish, with limited movement and a tendency to avoid light. The pupal stage resembles the larva but has a hardened texture, and its abdomen features claw-like structures. The adult beetle measures approximately 10 mm in length and 3 mm in width.

B. longissima is commonly found within the folds of coconut leaf pinnae or between pinnae, where it bores into the epidermal layer, creating elongated brown streaks in a linear pattern. These streaks are parallel to each other, and continuous feeding causes them to merge, leading to

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wrinkled leaves. Once the frond fully unfolds, the damaged leaves appear scorched.

Natural enemies play a crucial role in food chain cycles and are essential in agriculture for controlling pest populations. The utilization of natural enemies as a biological pest control method is an ecological approach provided by nature (Febronius, SST, 2020). This study aims to identify the potential natural enemies of *Brontispa longissima* in coconut plantations in North Minahasa Regency.

2. Material and Methods

This study was conducted in November 2023 in North Minahasa Regency, North Sulawesi Province (1.5328° N, 124.9948° E) at an altitude of 650 meters above sea level. The research was carried out in the form of a survey or direct field observation across three villages in North Minahasa Regency: Buda Village, Talawaan Bajo Village, and Kima Bajo Village.

In each village, one to two coconut plantations were selected, and within each plantation, ten coconut plants aged 1–3 years that were infested by *Brontispa longissima* were purposively sampled. From each selected plant, the infested young leaflets were collected, placed in plastic bags, and labeled with relevant information (district, village, plantation, and coordinates). These samples were then analyzed in the laboratory by separating the pest population into different developmental stages: eggs, early-instar larvae, late-instar larvae, pupae, and adults (imago). Each developmental stage was placed in separate containers for further observation of its natural enemies, including parasitoids, predators, and entomopathogens.

Predator observations were conducted through direct field surveys, and captured insects were placed in plastic clips. Parasitized pests were stored in test tubes until the parasitoids emerged. The emerging parasitoids were fed with a 50% honey solution, which was thinly applied to wax paper surfaces.

If entomopathogens were detected, laboratory isolation was conducted in the Biological Control Agent Clinic. The infected pests were cultured on Potato Dextrose Agar (PDA) medium and subsequently re-isolated until a pure culture was obtained for microscopic observation.

The percentage of *Brontispa longissima* infestation was determined by calculating the total number of sampled plants infested by *B. longissima* and analyzing the data using the following formula:

$$P = \frac{a}{b} \times 100\%$$

Description:
P = Percentage of *Brontispa longissima* infestation
a = Number of infested plants
b = Total number of sampled plants.

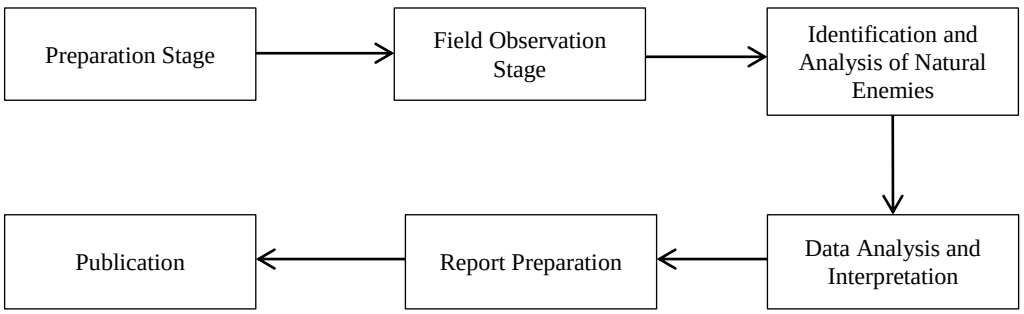

Figure 1. Research flow diagram

3. Results and Discussion

3.1. Population of *Brontispa longissima*

Based on research conducted in April 2024, the population of each developmental stage of *Brontispa longissima* in three villages in North Minahasa varied. The average population was dominated by the larval stage at 45.6%, followed by pupae at 35.8%, adults (imago) at 32.6%, and the lowest population was observed in eggs at 24.4% (Table 1). Larvae and adults of *B. longissima* attack unopened coconut leaves (fronds), boring into the epidermal layer and creating elongated streaks. These streaks cause reddish-brown spots, which, when continuously attacked, merge and cause the leaves to appear dry, wrinkled, and scorched when fully unfolded.

The pest prefers young, unopened leaves, while it avoids light. As a result, once the leaves open, the larvae and adults move to younger, still-closed leaves. Continuous infestation can lead to all the leaves drying out, which may result in plant death. *B. longissima* then moves to other plants that can provide the necessary food.

In severe infestations, coconut trees cease fruit production, and some may even die. This phenomenon was also observed in this study (Figure 2), where coconut leaves appeared brown, dried, and scorched due to heavy pest attacks.

3.2. Population of Natural Enemies

The natural enemies identified in three villages in North Minahasa Regency included the pupal parasitoid *Tetrastichus brontispae* (Hymenoptera: Eulophidae), the entomopathogenic fungus *Metarhizium anisopliae*, and the predator *Celisoches morio* (Dermaptera: Celisochidae). The most abundant natural enemy observed was the predator *C. morio* (Table 2).

Table 1. Developmental Stages of *B. longissima* in Different Locations

Location	Developmental Stages of *B. longissima*							
	Eggs	**L1**	**L2**	**L3**	**L4**	**L5**	**Pupae**	**Adults (Imago)**
Kima Bajo Village								
First Location	34	59	36	40	32	45	32	35
Budo Village								
First Location	29	54	31	33	35	56	32	34
Second Location	15	3	45	32	37	55	38	35
Talawaan Bajo Village								
First Location	26	46	38	32	26	59	45	33
Second Location	18	66	43	37	42	65	32	26
Total	122	228	193	174	172	280	179	163
Percentage (%)	24.4			45.6			35.8	32.6

a b c d e

Figure 2. Developmental stages of *Brontispa longissima*: egg (a), young larva (b), fifth instar larva (c), pupa (d), and adult (imago) (e).

Figure 3. Plant damage caused by *Brontispa longissima* infestation.

Table 2. Natural enemies of *Brontispa longissima* pests in three villages in North Minahasa Regency

Location	Natural enemies			
	T. brontispae	***M. anisopliae* in**		**Sum of cocopet**
	Pupa	**Larva**	**Imago**	
Kima Bajo Village				
First Location	0	0	0.05	1.05
Budo Village				
First Location	0	0	0.1	1.1
Second Location	0	0	0.05	1.35
Talawaan Bajo Village				
First Location	0.05	0	0.05	1.15
Second Location	0	0	0	1.3

3.3. Parasitoid *Tetrastichus brontispae* (Hymenoptera: Eulophidae)

The pupa parasitoid *Tetrastichus brontispae* is gregarious, meaning that from a single pupa of *B. longissima*, 7–41 or an average of 20.25 parasitoid imagoes can emerge. *T. brontispae* prefers older larvae and 1-2-day-old young pupae as breeding sites. Parasitized pupae of *T. brontispae* exhibit a gradual color change from light brown to dark brown, and the pupa's body becomes slightly swollen due to the parasitoid population inside. *T. brontispae* completes its egg, larval, pupal, and imago development in 17.43 days within *B. longissima*. The

larvae of *T. brontispae* have an indistinct head capsule, a characteristic feature of the Eulophidae family (Sopialena, 2018). The head capsule and eyes become clearly developed during the pupal stage. After the imago emerges from the pupa, it creates one to three exit holes on the surface of the *B. longissima* pupa. The imago of *T. brontispae* emerges individually through the holes it created.

3.4. Entomopathogen *Metarhizium anisopliae*

The pest infected with the entomopathogen *Metarhizium anisopliae* was only found in one village, Talawaan Bajo, with a low infection percentage. *M. anisopliae* requires humid conditions for its growth and development. The optimal temperature and humidity for *M. anisopliae* spore germination are between 24°-30°C and 92.5-100%, respectively (Singh and Rethinam, 2004).

According to Aw and Hue (2017), the process of fungal penetration into the insect's body is aided by cuticle-degrading enzymes such as lipase, proteinase, and chitinase. After the conidia germinate, they produce mycelium, which plays a role in spreading and infecting the host. The mycelial propagule then spreads throughout the body cavity via haemolymph flow. After entering the insect's body cavity, the fungus produces a toxin compound called destruxin, which damages the host body and spreads to the haemocel tissue, leading to the insect's death (Paradza et al., 2022).

The attack symptoms on the imago are characterized by the death of the imago, followed by the growth of white mycelium on the surface of the imago's body, especially between the segments of the thorax and abdomen, where green-colored conidia will form. The mycelium and conidia serve as a source of infection for other healthy pests. Unlike viruses, pathogenic fungi enter the insect's body not through the digestive system but directly through the skin or integument (Paradza et al., 2022).

The entomopathogenic fungus *M. anisopliae* was observed microscopically, and its identification was carried out using the entomopathogen fungus determination key by Humber (2005). The morphological microscopic identification revealed that *M. anisopliae* has septate mycelium, with upright conidiophores of varying sizes and branching, covered with hyaline conidia, which are shaped like rice grains or cylindrical (Humber, 2005) (Figure 3).

3.5. Predator *Celisoches morio*

Celisoches morio (cocopet) is a common predator found at the observation sites (Table 2), with population percentages in each location as follows: 1.35% in the second location of Budo Village, followed by 1.15% in the second location of Talawaan Bajo Village, 1.3% in the first location of Talawaan Bajo Village, and the lowest at 1.1% in Kima Bajo Village. The description of *C. morio* includes a body length of 2-3 cm. This species has 18 segments on its antennae, and its body is generally black, from the head to the thorax, abdomen, and forceps, which is why it is called the black Dermaptera. The forceps of this species are unitary, with the tips curving inward and serrated on the inside (Setiawati et al., 2023).

The predator feeds on multiple developmental stages of the pest, including larvae, pupae, and imagoes, and can continuously prey throughout its life. The population of this predator is typically high on coconut plants with high *B. longissima* populations, which correlates with food availability (Singh and Rethinam, 2005). According to research by Alouw and Hosang (2008), the average number of second-instar larvae that can be consumed within 24 hours is 23.5 individuals. Factors affecting the high consumption of first and second instar larvae are the body color of the larvae. The body of first-instar larvae is brighter white than that of third and fourth instar larvae, making them more preferred by *C. morio*. This is in line with Edy et al. (2008), who stated that morphological factors, other than body size, that affect predation include the prey's color, such as orange-colored eggs, brownish-black-colored pupae, and white-colored larvae. In the third and fourth instar phases, the predation ability of *C. morio* decreases, which is due to several factors, including body size and morphology. Larger body sizes and hardened body parts, such as the thorax and head, require more time for *C. morio* to consume the prey (Alow, 2009).

The predation behavior of *C. morio* begins with recognizing the prey. It approaches the prey silently, circles around *B. longissima* larvae, and moves its antennae more actively. It then incapacitates the larvae with its forceps and feeds on the fluids and flesh of the larvae from one side, causing the larvae to turn black. This is similar to the observations by Arobi et al. (2013), who noted that the orientation behavior of the Dermaptera predator begins with recognizing the prey. The predator approaches the prey quietly and moves its antennae more actively. *C. morio* uses its forceps to capture the prey, bending its body to feed on the *B. longissima* body. If the *B. longissima* does not move, it will release its grip and continue feeding. While feeding, *C. morio* may also use its forceps to capture other pests that touch its body.

4. Conclusion

Potential natural enemies of *Brontispa longissima* Gestro pests on coconut plants in North Minahasa Regency, as observed in this study, are reflected in the population of natural enemies found in the field, specifically the cocopet predator *C. morio*. This predator is abundant in the field and not only preys on a single developmental stage but on almost all pest stages, including larvae, pupae, and imago, and can continuously prey throughout its life.

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