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Diversity and Abundance of Entomopathogenic Fungi and Their Hosts in Rice Fields of Kembang Mertha Village-Bolaang Mongondow

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ABSTRACT

The diversity of entomopathogenic fungi in an area can provide information about the potential for controlling insect pests. This is important to do to find suitable biological control agents to reduce the impact of using synthetic pesticides. This research was conducted to look at the diversity and abundance of entomopathogenic fungi and their host insects, so that potential entomopathogenic fungal and pest species were identified in the rice fields of Kembang Mertha Village. The results obtained were four species of host insects, namely Leptocoarisa oratorius, Schotinopara coarctata, Ricelia dorsalis and Nilaparvata lugens, and three species of entomopathogenic fungi, namely Beauveria bassiana, Metarhizium sp. and Hirsutella sp.. The host insect diversity indices in the medium category were S. coarctata (1.10) and N. lugens (1.04) and for entomopathogenic fungi, the three fungal species found were in the medium category respectively B. bassiana (1.31), Metarhizium sp. (1.07) and Hirsutella sp. (1.05). The highest abundance index values for host insects were S. coarctata (84.62%) and N. lugens (50%), while for pathogenic fungi were Hirsutella sp. (43.73%).

*Keywords**:** S. coarctata; N. lugens; Hirsutella sp.; Diversity Index; Abundance Index*

INTRODUCTION

It is very important to increase the yield of rice (*Oryza sativa* L.), one of the main food crops. To increase the productivity of rice plants there are several obstacles such as rainfall, climate, plant diseases, including pest attacks. *O. sativa* was reported to be attacked by 21 species of pests classified as major pests (Ane and Hussain, 2015; Rizal *et al*., 2017). If not controlled, the presence of these pests can cause damage and decrease in crop productivity (Trizelia *et al*., 2015).

So far, the use of synthetic pesticides more than the recommended amount is an effort that is often made by farmers to control pests. Excessive use of synthetic pesticides can have a negative impact by causing various problems such as pest resistance, destruction of natural enemies and beneficial insects, environmental pollution, and loss of biodiversity (Leksono *et al*., 2019).

Reducing these negative impacts requires serious efforts, one of which is biological control. Biological control is expected to inhibit the growth of pests using natural enemy biological agents such as predators, parasitoids, viruses, fungi, and bacteria (Abidin *et al*., 2017). The use of biological agents provides advantages including, biological control does not have a negative effect on humans and the environment, several types of biological control agents can be used as biological insecticides and generally pest species are unable to develop resistance to biological control agents. Entomopathogenic fungi are one of the biological agents that are widely used as an alternative control with an environmental perspective.

Entomopathogenic fungi can be used as biological control agents and are widely developed and used. The diversity of entomopathogenic fungi in an area can inform pest management options. The high diversity of entomopathogenic fungi allows pest populations to be controlled below economic thresholds (Handoko *et al.*, 2017). This makes knowledge of scientific data on the diversity of entomopathogenic fungi very important as a basis for considering the provision of biological control agents. Research on the diversity and abundance of entomopathogenic fungi and host insects has never been carried out in Kembang Mertha village-Dumoga Timur, even though Kembang Mertha village as a rice farming area has potential as a place to explore entomopathogenic fungi as biological control agents for insect pests.

Since the village of Kembang Mertha, a rice cultivation area, is also attacked by pests, it is necessary to study local entomopathogenic fungi that can control these pests. Therefore, this study was conducted to obtain data on potential host species controlled by entomopathogenic fungi and entomopathogenic fungal species that can be used as biological control agents by studying the diversity and abundance of entomopathogenic fungi and their insect hosts in rice growing areas.

MATERIALS AND METHODS

This research was conducted from January to March 2023 in the Kembang Mertha Village, East Dumoga District-Bolaang Mongondow. This research is an exploratory study using the quadrant plot method measuring 1 m x 1 m. At the research location, three stations were determined in the rice field area using a purposive random sampling method, where this determination was based on the age of the rice plants.

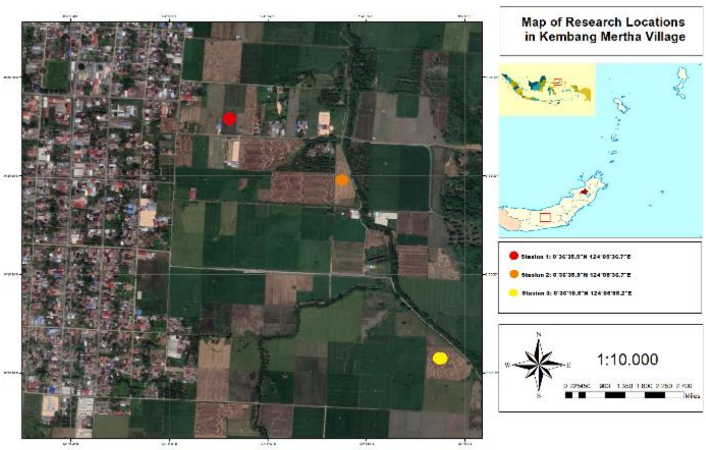

Figure 1. Map of research locations in Kembang Mertha Village

Sampling was carried out by placing 10 quadrant plots measuring 1 m x 1 m at each station. Insects that had been infected with the fungus were then taken as samples, and identified at the Advanced Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Sam Ratulangi University, Manado. Calculation of the number of entomopathogenic fungi is based on the number of infected insect pests.

The diversity of entomopathogenic fungi and their hosts was calculated using the Shanon-Wiener Diversity Index.

$$H' = -\sum_{i=1}^{n} pi \ln pi$$

H'= Shanon-wiener Diversity Index

pi = comparison of the number of individuals of the i-th species (ni) with the total number of individuals (N). Three categories of diversity index, namely Low (H'<1), Medium (1 < H' < 3), and High (H' > 3)

The abundance of entomopathogenic fungi and their hosts was calculated using the Abundance Index.

$$A = \frac{Number\ of\ species - i}{Total\ number\ of\ individuals} \times 100\%$$

Identification of entomopathogenic fungi was carried out using a combined method (Toledo *et al*.,2013; Herdatiarni *et al*., 2014; Kulu *et al*.,2015; Priyatno *et al*., 2016; Sirait *et al*., 2018).

RESULTS AND DISCUSSION

Exploration of Entomopathogenic Fungi and Host Insects

A study on entomopathogenic fungi and insect host species was conducted by collecting all pest species prevalent in rice fields in Kembang Mertha Village and securing four insect host species: *L. oratorius*, *S. coarctata*, *R. dorsalis*. and *N. lugens*; Three entomopathogenic fungi, namely *B. bassiana*, *Metarhizium* sp., and *Hirsutella* sp. (Figure 2).

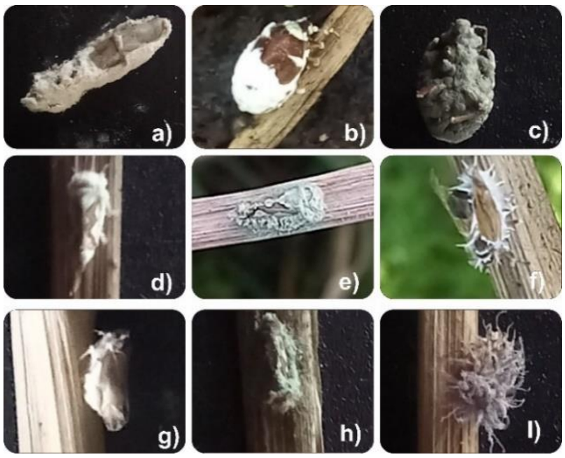

Figure 2. Types of entomopathogens found in Kembang Mertha Village. a) *B. bassiana* infects *L. oratorius*; b) *B. bassiana* infects *S. coarctata*; c) *Metarhizium* sp infects *S. coarctata*; d) *B . bassiana* infects *R. dorsalis*; e) *Metarhizium* sp infects *R. dorsalis*; f) *Hirsutella* sp. infected *R. dorsalis*; g) *B. bassiana* infects *N. lugens*; h) *Metarhizium* sp infects *N. lugens*; i) *Metarhizium* sp infects *N. lugens*.

According to the study results, the number of entomopathogenic fungi was highest in host *N. lugens* (28.0) and least in host *L. oratorius* (4.3). *Hirsutella* sp. It mainly attacks *N. lugens* (14.0) and *S. coarctata* (6.3). The fungus *B. bassiana* is the most common fungus affecting hosts of *L. oratorius* (3.7), whereas *R. dorsalis* was most affected by the fungus *Metarhizium* sp. (9.7). According to research data, *N. lugens* is the type of host that can be controlled with the highest value compared to other pests. The type of entomopathogenic fungi that can be biological agents in Kembang Merta village is *Hirsutella* sp. This is because it scored the highest for two of the four pest species found.

Table 1. The average number of entomopathogenic fungi in Kembang Mertha village

Host Inang	Entomopathogenic type			Total
	B. bassiana	*Metarhizium sp*	*Hirsutela sp*	
L. oratorius	3,7	0,0	0,7	4,3
S. coarctata	6,0	5,3	6,3	17,7
R. dorsalis	2,3	9,7	9,0	21,0
N. lugens	7,0	7,0	14,0	28,0
Total	19,0	22,0	30,0	71,0

A survey of insects infected with entomopathogenic fungi in the village of Kembang Merta Bolaang Mongondow showed that the pests that tend to be hosts are *N. lugens* insects with the entomopathogenic fungus *Hirsutella* sp. The results obtained differ from studies conducted by Siahaan *et al*. (2020) showing that *B. bassiana* predominates among entomopathogenic fungi that infect *N. lugens* in three different areas of Bolaang Mongondou. These differences may be caused by several factors, such as pesticide use (Trizelia *et al*., 2015) and the virulence of entomopathogenic fungi (Li *et al*., 2014).

Excessive use of pesticides by farmers in Kembang Mertha is one of the reasons for the decline in pests, which is thought to indirectly reduce entomopathogenic fungal infections. In addition to excessive use of insecticides, the degree of infection by entomopathogenic fungi is greatly influenced by the virulence of the fungus, while the virulence of entomopathogenic fungi is greatly influenced by environmental factors such as temperature and humidity (Hsia *et al*.,2014).

Diversity of Entomopathogenic Fungi and Their Hosts

The determination of diversity is based on the Shannon-Wiener diversity index with two forms of calculation. The first diversity was based on the type of entomopathogenic fungi while the second was based on the type of infected insect host.

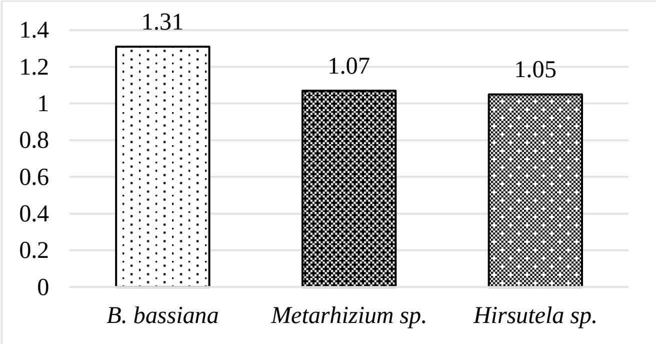

Figure 3. H' value of entomopathogenic fungi in Kembang Mertha village

As for the diversity value of entomopathogenic fungi in Kembang Merta village, *B. bassiana* showed the highest index value (1.31), and *Metarhizium* sp. (1.07), the lowest index value is *Hirsutella* sp. (1.05) (Figure 3). Based on the index values obtained, the diversity values of the three mushroom species fall in the middle category. Based on diversity index values, *B. bassiana* is a potential entomopathogenic fungus because it has a higher H' value than the other two species of fungi.

A variety of entomopathogenic fungi can have a beneficial effect on pest control. However, excessive use of synthetic pesticides by farmers will affect the reduction of entomopathogenic fungi (Handoko *et al*., 2017). The overuse of synthetic pesticides by farmers in the paddy fields of Kembang Merta is believed to be the main cause of various entomopathogenic fungi belonging to the temperate category. According to (Handoko *et al*., 2022), the use of recommended amounts of synthetic pesticides does not adversely affect the diversity of entomopathogenic fungi.

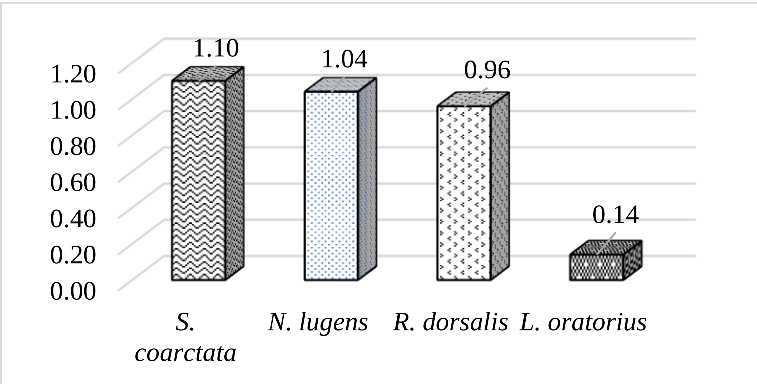

Figure 4. Host H' Value of entomopathogenic fungi in Kembang Mertha village

The highest host diversity values were *S. coarctata* (1.10), *N. lugens* (1.04), and *R. dorsalis* (0.96), and the lowest was *L. oratorius* (0.14) (Figure 4). The insect hosts of *S. coarctata* and *N. lugens* were moderately diverse, but *R. dorsalis* and *L. oratorius* belongs to the lower category. These results indicate that the hosts of *N. lugens* and *S. coarctata* are pests attacked by more diverse fungal pathogens than the other two species.

The low H' value of the host *L. oratorius* is since this insect host is only attacked by two pathogenic fungi, *B. bassiana* and *Hirsutella* sp., whereas the host *R. dorsalis* is attacked by fungi. Infecting this insect is *Hirsutella* sp. compared to two other pathogenic fungal species. Data on insect host diversity indicate that the species *N. lugens* and *S. coarctata* are the most potential pests to fight entomopathogenic fungi when compared to the other two insect pest species.

The Abundance of Entomopathogenic Fungi and Their Hosts

The abundance of entomopathogenic fungi and their hosts was calculated using the abundance formula with two forms of calculation, namely based on the type of entomopathogenic fungi and the second based on the type of host.

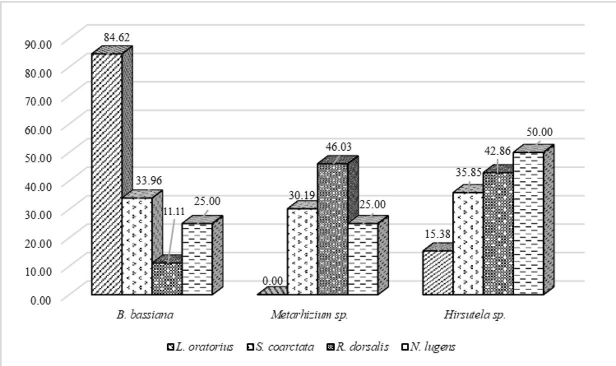

Figure 5. Entomopathogenic fungi abundance value based on host type in Kembang Mertha village

The abundance of entomopathogenic fungi for *L. oratorius* by type was *B. bassiana* (84.62%), *Hirsutella* sp. (15.38%) (Figure 5). Almost uniform abundance values were obtained for the host *S. coarctata*, with the highest being *Hirsutella* sp. (35.85%) followed by *B. bassiana* (33.96%) and the lowest was *Metarhizium* sp (30.19%). the most abundant *R. dorsalis* were *Metarhizium* sp (46.03%), *Hirsutella* sp. (42.86%), *B. bassiana* showed the lowest percentage (11.11%). For the host *N. lugens,* the highest abundance value is *Hirsutella* sp. (50%) *B. bassiana,* and *Metarhizium* sp. 25% each.

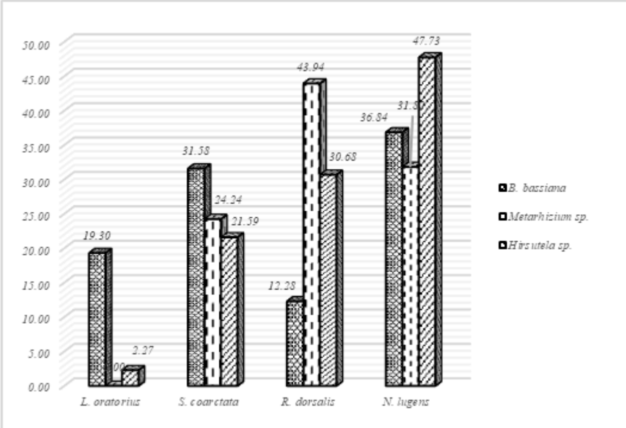

Figure 6. Abundance value of hosts infected with entomopathogenic fungi in Kembang Mertha village

The entomopathogenic fungus *B. bassiana* was found to be most abundant in the insect host species *N. lugens* (36.84%) and least abundant in the insect host *R. dorsalis* (12.28%). Mushroom *Metarhizium* sp. It was found in abundance in the insect host *R. dorsalis* (43.94) and not in the insect host *L. oratorius* (0.00%). Hirsutela sp. insect host *N. lugens* (47.73%), the smallest being the host insect *L. oratorius* (2.27) (Figure 6). Judging by the number of infected hosts, the entomopathogenic fungi *B. bassiana* and *Hirsutella* sp. It is the most potentially entomopathogenic fungus compared to *Metarhizium* sp.

The entomopathogenic fungus *B. bassiana* was found to infect all types of insects with a relatively high abundance when compared to the fungus *Metarhizium* sp., this is because the fungus *B. bassiana* has a high ability to germinate conidia (Nuraida and Hasyim, 2009) and good pathogenicity (Effendy *et al*., 2011) compared to *Metarhizium* sp. In addition, *B. bassiana* is known as an entomopathogenic fungus with a broad spectrum of attacks against insect pests. This ability makes this fungus very potential to be a biological control agent.

Besides *B. bassiana*, the abundance of *Hirsutella* sp. is also very high especially in the pests *N. lugens* and *R. dorsalis*, this is following Wawan *et al*., (2017) which stated that *Hirsutella citriformis* has a very high pathogenicity and effectively suppresses the *N. lugens* population in the field so that *Hirsutella* sp. potential to be used as a biological control agent. However, efforts to use these fungi on a large scale are still facing problems, because these fungi cannot be grown on artificial media (Yusak Wongkar, Personal Communication), this is in line with the statement of Wawan *et al*. (2017) who stated that the use of *H. citriformis* on a large scale was constrained by the low germination rate of conidia on artificial media. Seeing the potential for the pathogenicity of *Hirsutella* sp. in the field, effective propagation media must be further investigated to obtain suitable artificial growth media, so that the potential of this fungus can be utilized properly.

Given the potential, the use of entomopathogenic fungi, especially local isolates, should be done on a large scale. This is important to reduce overuse as synthetic pesticides have enormous negative effects. One consequence of the overuse of synthetic insecticides is that the natural enemies of insect pests, such as entomopathogenic fungi, are not diverse and abundant.

CONCLUSION

The host insect diversity index of *S. coarctata* and *N. lugens* was in the medium category, while the host insects *R. dorsalis* and *L. oratorius* were in the low category. The diversity index of entomopathogenic fungi for three species of fungi found was in the moderate category. The highest abundance index for host insects was *S. coarctata*, while for pathogenic fungi was *Hirsutella* sp.. Based on the diversity and abundance data, the insect pests that had the most potential to be controlled were *S. coarctata* and *N. lugens*, while entomopathogenic fungi had the potential as biological agents. is *Hirsutella* sp..

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