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Host Diversity of *Beauveria Bassiana* (Balsamo) Vuillemin on Rice Field in Bolaang Mongondow Regency

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ABSTRACT

Beauveria bassiana can attack a variety of hosts and their virulence can vary at each host and location. Exploration of the diversity of hosts *B. bassiana* from local isolates needs to be done as initial information that can explain the ability of *B. bassiana* in infecting insects. Sampling locations were selected in three district, each district selected three stations and each station consisted of 10 plots. The location of sampling is determined by the purposive random sampling method. Each station was made a plot measuring 1m x 1m and distributed randomly. Every insect infected with *B. bassiana* was taken and taken to a laboratory for identification. The results showed that there were five insects that hosted *B. bassiana*, namely *Nilaparvata lugens*, *Scotinophara coarctata*, *Leptocorisa oratorius*, *Nezara Viridula* and *Paraeucosmetus pallicornis*. The highest host diversity index was found in North Dumoga with a value of 1.47. The highest abundance index was found in *N. lugens* host in East Dumoga with a value of 43%. The highest density was found in the host *N. lugens* in Central Dumoga with a value of 1.93 ind / m2. There were indications of differences in virulence of the *B. bassiana* local isolates that were influenced by the spesies of host and location.

INTRODUCTION

Rice ecosystems can be an ideal source of entomopathogenic fungi. As reported by Rosmini and Lasmini (2010) there were five entomopathogenic fungi that attacked the green leafhopper (*Nephotettix viresens*) in rice field in Donggala Regency, one of which was *Beauveria* sp. Exploration of entomopathogenic fungi in rice cultivation needs to be done to provide biological agents that can replace the role of synthetic pesticides (Rizal *et al*. 2017). Bolaang Mongondow Regency, North Sulawesi Province is a center of rice production that experiences various pest attacks (Mandei *et al*., 2011; Kila *et al*., 2016; Kanakan *et al*., 2017). Naturally, planting sites in this region must contain entomopatogenic fungi that are usually associated with rice pest insects. Exploration of local entomopathogenic fungi can be an environmentally friendly pest control alternative. One of the entomopathogenic fungi that is promising to be utilized is *B. bassiana*.

Fungi *B. bassiana* is one of the entomopathogenic fungi that has been known its effectiveness as a plant pest control (Anggarawati *et al*., 2017). This

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color of fungus colonies at in vitro media is white flour. The colonies will turn yellowish or reddish after aging (Effendy *et al*., 2010). *B. bassiana* has been known to attack several species of insects, both pest insects, disease vector insects, and other insects. Previous work of Priyatno *et al*. (2016) showed that *B. bassiana* attacked stinky bugs (*Leptocorisa oratorius*), black ladybugs, and brown stem plant hopper (*Nilaparvata lugens*). According to Valero-Jiménez *et al*. (2014) this entomopathogen have also been used to control *Anopheles coluzzii* mosquitoes, a vector for malaria. Mwamburi *et al*. (2015) reported that *B. bassiana* could be used to control house flies (*Musca domestica*). *B. bassiana* was also reported to attack crickets (*Gryllus* sp.) (Ardiyati *et al*., 2015).

The virulence of *B. bassiana* has been known to vary depending on the origin, genetic diversity, the stage of the insect and the host. Valero-Jiménez *et al*. (2016) reported that there were several genes and molecular processes that could influence the virulence of *B. bassiana* against mosquitoes. Huang *et al*. (2019) reported that *B. bassiana* had different virulence qualities at each stage of *Haemaphysalis longicornis*. In India Bhadauria *et al*. (2013) reported no correlation between *B. bassiana* virulence and host insect origin. However, in China, Li *et al*. (2014) reported that *B. bassiana* isolates had different virulence at each host and each location.

Based on this information it can be seen that *B. bassiana* can attack various hosts and their virulence can vary at each host and location. For this reason, a preliminary study on the diversity of *B. bassiana* hosts originating from local isolates, Bolaang Mongondow Regency needs to be done. This study aims to analyze the diversity, abundance, and density of host insects infected by *B. bassiana* local isolates.

MATERIALS AND METHODS

The study was conducted from April 2019 to February 2020 in Bolaang Mongondow Regency, North Sulawesi. Three sub-districts were taken as sample locations and three stations were made as replications in each sub-district. Station selection was carried out using a purposive random sampling method based on rice age. Each station was made with a plot size of 1m x1 m, 10 plots were distributed randomly. All fungal-infected insects were collected and then were identified and selected at the Laboratory of Biological Agents, Center for Plant Protection and Horticulture, North Sulawesi Agriculture and Animal Husbandry Office.

$$A = \frac{Number\ of\ individual\ spesies\ i-th}{Number\ of\ individual\ of\ all\ spesies} \times 100\ \%$$

Host diversity index was calculated using the Shannon-Wiener Diversity Index (Stilling, 2012).

$$H' = -\sum_{n=1}^{s} pi\ lnpi$$

H ' = Diversity Index
Pi = Comparison of the number of i-th individuals (ni) with the total number of whole individuals (N)
s = The number of species in the sample

The Host Abundance Index was calculated using the Abundance Index according to Fachrul (2007).

Host Density Index was calculated using the Density Index according to Stilling (2012).

$$D = \frac{\Sigma xi}{L}$$

Xi = Number of i-individuals
L = area of sample (m^2)

The identification of entomopathogenic fungi using the method in accordance with Nuraida and Hasyim (2009), Herdatiarni *et al*. (2014), Kulu *et al*. (2015), Trizelia *et al*. (2015), and Priyatno *et al*. (2016).

RESULTS AND DISCUSSION

Exploration of the host B. bassiana

The exploration showed that insects infected with *B. bassiana* were found in each district. Five species of host insects infected with *B. bassiana* were found in all district. The host insects were *Nilaparvata lugens, Scotinophara coarctata, Leptocorisa oratorius, Nezara viridula,* and *Paraeucosmetus pallicornis*. Data from Central Dumoga, North Dumoga, and East Dumoga showed that the highest infected *B. bassiana* insect was *N. lugens* with successive values of 1.93, 1.40, 1.07 and the lowest was *N. viridula* with successive values i.e. 0.20, 0.17, and 0.07 (Table 1).

Insects found infected with *B. bassiana* were common insect pests found in the rice ecosystem. *N. lugens* was one of the main pests of rice that is plastic which was easy to adapt to the environment and attacked the plant by sucking the liquid stem to dry (Nurbaeti *et al*., 2010). *S. coarctata* was a pest that caused huge losses in rice plantations because it attacked almost all stages of rice growth (Sepe and Demayo, 2017). *L. oratorius* is an important pest of rice because its presence can cause yield losses. Generally these pests attack at generative growth in rice (Kartohardjono *et al*., 2009). *N. viridula* is a pest that is commonly found in Legumes (CABI, 2016). This pest is an important pest in rice plants which causes considerable damage and is detrimental to the economy (Jones, 1988). *P. pallicornis* was a new pest since the 1980s that caused damage in rice plants in Bolaang Mongondow which had been watched out (Sembel, 2014).

Diversity Index of B. bassiana Host (H')

Diversity index of *B. bassiana* host varied among district. The highest value was found in North Dumoga District (H'=1.47), followed by Central Dumoga District (H'=1.45), with the lowest was found in East Dumoga District (H'=1.38) (Figure 1).

The H' value obtained indicated that the diversity of host *B. bassiana* in all district was considered to be in the medium category (Alikodra, 2002). This showed that *B bassiana* had moderate or quite diverse hosts. Ecosystem conditions were quite balanced to sustain the survival of *B. bassiana*. Among the sample districts, East Dumoga district was the weakest district in supporting the life of *B. bassiana* while North Dumoga was an excellent district in supporting the life of this fungus.

The diversity index was highly dependent on

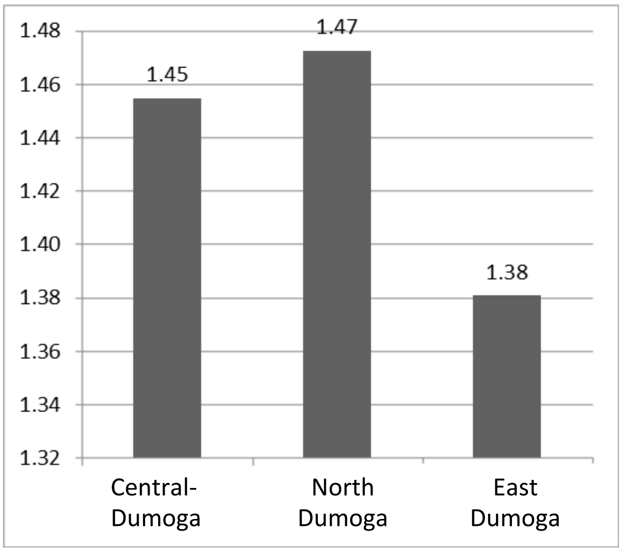

Figure 1. Population Fluctuations of Hemiptera (Alydidae) (Left) and Coleoptera (Coccinellidae) (Right), the dominant catch with a sweep net.

Tabel 1. Succesive value and host of *B. bassiana* in three district of Bolaang Monondow Regency.

Location (District)	Host Spesies (Infected Insects)	Means
Central Dumoga	*Nilaparvata lugens*	1.93
	Scotinophara coarctata	1.47
	Leptocorisa oratorius	0.93
	Nezara viridula	0.20
	Paraeucosmetus pallicornis	1.17
Total		5.70
North Dumoga	*Nilaparvata lugens*	1.40
	Scotinophara coarctata	0.80
	Leptocorisa oratorius	1.10
	Nezara viridula	0.17
	Paraeucosmetus pallicornis	0.87
Total		4.33
East Dumoga	*Nilaparvata lugens*	1.07
	Scotinophara coarctata	0.53
	Leptocorisa oratorius	0.40
	Nezara viridula	0.07
	Paraeucosmetus pallicornis	0.40
Total		2.47

the evenness of the number of individuals between species rather than on richness per species. So the high or low value of the diversity index depends on the evenness between species (Solle, *et al*., 2017). This indicated that the difference in the number of fungal infections between hosts in the District of North Dumoga was not large because it had the highest diversity index, which was proportionally inversed to the District of East Dumoga. The low diversity index value indicated the difference in the number of infections between hosts was very large when compared to the other two districts.

Abundance Index of Host B. bassiana

The results showed that *B. bassiana* was abundant in *N. lugens* host in all district with the following values; Central Dumoga District 34%, North Dumoga District 32%, and East Dumoga 43% (Table 2).

The high abundance of *B. bassiana* in *N. lugens* showed that these hosts were most often attacked by *B. bassiana*. This could possibly be caused by the population size of the pest (*N. lugens*) being quite high. According to Mardiana (2018) and Chandra (2019) population size can affect the spread of pathogens. In this case the greater the size of the *N. lugens* population, the more individuals in this population were infected by *B. bassiana*. The phenomena was found on *N. viridula*, the abundance of *B. bassiana* in these insects were very low, ranging from 3 - 4%. This showed that the population *N. viridula* was very low in rice plants in the three districts.

The Abundance Index obtained explains the high and low values of the diversity index. As mentioned earlier that the difference in the number of individuals between species can affect the value of the diversity index obtained. The difference in the number of species between infected species in North Dumoga was low. The difference in the value of the abundance index between *N. lugens* (32%) and *L. oratorius* (25%) was 7%. The difference in value of abundance index between *N. lugens* (32%) and *S. coarctata* (18%) was14% and the difference in value of abundance index *N. lugens* (32%) with *N. viridula* (4%) was 28%, these were what causing the high value of diversity in the North Dumoga District. The opposite result was found in East Dumoga District where the difference between the abundance index values of *N. lugens* (43%) and *S. coarctata* (22%) was 21%. The difference in the value of abundance index of *N. lugens* (43%) with *L. oratorius* and *P. pallicornis* (16%) was 27%, while the difference in the value of abundance index of *N. lugens* (43%) with *N. viridula* (3%) was 40%. The difference in the index of abundance among different spesies of hosts was very large in East Dumoga, this caused the value of the diversity index in this area to be the lowest compared to the other two districts.

Density Index of B. bassiana Based on Its Host

Density Index in all district showed that *N. lugens* insects had the highest density per m^2. Successively from the District of Central Dumoga, North Dumoga, and East Dumoga, the values were as follows; 1.93 ind/m^2, 1.40 ind/m^2, 1.07 ind/m^2 (Table 3).

The Density Index describes the population size in an area that is affected by the habitat area and the number of similar individuals found in the area (Suin, 2003). Based on the data obtained showed that the largest population size was in Central Dumoga where the largest population was found in the population of *N. lugens* followed by *S. coarctata, P. pallicornis, L. oratorius* and *N. viridula*. In North Dumoga the largest population was found in *N. lugens* followed by *L. oratorius, P. pallicornis, S. coarctata, and N. viridula*. In East Dumoga the largest population was *N. lugens* followed

Table 2. *Beauveria bassiana* abundance index for each host in three district of Bolaang Monondow Regency.

Location (District)	Abundance Index (%)				
	N. lugens	*S. coarctata*	*L. oratorius*	*N. viridula*	*P. pallicornis*
Central Dumoga	34	26	16	4	20
North Dumoga	32	18	25	4	20
East Dumoga	43	22	16	3	16

Table 3. *Beauveria bassiana* Density Index for each host in three district of Bolaang Monondow Regency

Location (District)	Host Spesies	Number of individuals/m^2
Central Dumoga	*Nilaparvata lugens*	1.93
	Scotinophara coarctata	1.47
	Leptocorisa oratorius	0.93
	Nezara viridula	0.20
	Paraeucosmetus pallicornis	1.17
Total		5.70
North Dumoga	*Nilaparvata lugens*	1.40
	Scotinophara coarctata	0.80
	Leptocorisa oratorius	1.10
	Nezara viridula	0.17
	Paraeucosmetus pallicornis	0.87
Total		4.33
East Dumoga	*Nilaparvata lugens*	1.07
	Scotinophara coarctata	0.53
	Leptocorisa oratorius	0.40
	Nezara viridula	0.07
	Paraeucosmetus pallicornis	0.40
Total		2.47

by *S. coarctata, L. oratorius* and the smallest were *P. pallicornis* and *N. viridula* which had the same population size. The intended population size refers to the size of the population affected by *B. bassiana* attacks. Therefore, the population of *N. lugens* was the population of pests experiencing the greatest impact of attacks by *B. bassiana* so that *B. bassiana* isolates from Bolang Mongondow Regency had good effectiveness in controlling the population of *N. lugens*.

The *N. lugens* density index was always the highest and the *N viridula* was always the lowest in the three district while the other three hosts (*S. coarctata*, *L. oratorius* and *P. pallicornis*) had density index that always varied in each district.This was an indication that there was a difference in virulence at each host and at each location against *S. coarctata, L. oratorius and P. pallicornis*.

CONCLUSION

There were five species of insects found as the hosts of *B. bassiana* with varied diversity index values in each district, namely Central Dumoga 1.45, North Dumoga 1.47, and East Dumoga 1.38. The highest abundance index was found in *N. lugens* host in all districts with the value of Central Dumoga 34%, North Dumoga 32%, and East Dumoga 43%. The highest density index was found in *N. lugens* hosts in all district with a value of 1.93 individuals /m^2 in Central Dumoga, 1.40 individuals /m^2 in North Dumoga, and 1.07 individuals /m^2 in East Dumoga. There were indications of differences in *B. bassiana* virulence by host species and locations that attack *S. coarctata, L. oratorius* and *P. pallicornis* insects.

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