

Species and Number of Individuals of Diurnal Insect Predators of *Spodoptera frugiperda* J.E SMITH in Bantul Regency

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Article information		ABSTRAK
Article history		Ulat Grayak (<i>Spodoptera frugiperda</i> J.E. Smith) merupakan hama jagung yang berasal dari Amerika dan telah masuk ke Indonesia. Ulat Grayak telah menyebabkan kerugian pada beberapa wilayah di Indonesia sehingga diperlukan pengendalian hama melalui serangga predator. Tujuan penelitian mengidentifikasi jenis serangga predator diurnal dan menemukan jumlah serangga predator diurnal paling melimpah dan paling sedikit di Kabupaten Bantul. Penelitian dilaksanakan bulan Januari 2022-Juni 2023 pada lahan jagung di Kabupaten Bantul. Penentuan desa sebagai lokasi sampling menggunakan metode <i>stratified random sampling</i> . Lahan jagung yang digunakan ditentukan dengan metode <i>purposive</i> . Analisis data yang digunakan adalah analisis deskriptif dan inferensial. Analisis deskriptif digunakan untuk mendeskripsikan jenis-jenis predator diurnal, dan jumlah paling melimpah dan paling sedikit di Kabupaten Bantul. Berdasarkan hasil penelitian didapatkan 12 jenis predator diurnal. Jenis paling banyak ditemukan adalah <i>M. sexmaculatus</i> (109 ekor), sedangkan paling sedikit adalah <i>Formica</i> sp. dan <i>Sycanus</i> sp. masing-masing 5 ekor. Jenis serangga predator diurnal paling banyak adalah <i>M. sexmaculatus</i> 109 ekor dan <i>V. lineata</i> 107 ekor. Kesimpulannya, keanekaragaman serangga predator diurnal yang ditemukan dapat dipertimbangkan untuk pengendalian hayati hama <i>Spodoptera frugiperda</i> . Implikasi penelitian ini adalah pentingnya penggunaan serangga predator diurnal sebagai agen pengendali hayati untuk mengurangi kerugian panen jagung yang akibat hama.
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Kata kunci: <i>Formica</i> sp. <i>Menochilus sexmaculatus</i> Persebaran <i>Sycanus</i> sp. <i>Verania lineata</i>		ABSTRACT The armyworm (<i>Spodoptera frugiperda</i> J.E. Smith) has caused losses in several regions of Indonesia, so pest control using predatory insects is necessary. The purpose of this study was to identify the types of diurnal predatory insects and find the most abundant and least abundant diurnal predatory insects in Bantul Regency. The study was conducted from January 2022 to June 2023 in corn fields in Bantul Regency. The determination of villages as sampling locations used a stratified random sampling method. The corn fields were selected using a purposive sampling method. Data analysis used descriptive and inferential analysis. Descriptive analysis was used to describe the types of diurnal predators, and the most abundant and least
Keywords: <i>Formica</i> sp. <i>Menochilus sexmaculatus</i> Distribution <i>Sycanus</i> sp. <i>Verania lineata</i>		

abundant in Bantul Regency. Based on the study's results, 12 types of diurnal predators were identified. The most abundant species was *M. sexmaculatus* (109 individuals), while the least abundant were *Formica sp.* and *Sycanus sp.* with 5 individuals each. The most abundant diurnal predatory insect species were *M. sexmaculatus* (109 individuals) and *V. lineata* (107 individuals). In conclusion, the diversity of diurnal predatory insects found can be considered for biological control of *Spodoptera frugiperda*. The implication of this research is the importance of employing diurnal predatory insects as biological control agents to reduce pest-related losses in the corn crop.

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INTRODUCTION

The fall armyworm (*Spodoptera frugiperda* J.E. Smith) is an insect pest of maize that originated in the Americas and has spread to Asia (Goergen *et al.*, 2016), including Indonesia (Kementan, 2019). *Spodoptera frugiperda* attacks corn plants from the vegetative to generative phase (Alpian *et al.*, 2021). Losses due to this pest attack on corn agriculture in Indonesia reached 120 billion rupiah in East Nusa Tenggara (Yulianto *et al.*, 2020). Until now, *S. frugiperda* has been reported to attack corn plants in several regions in Indonesia, such as West Java (Maharani *et al.*, 2019), East Java (Megasari and Khoiri, 2021) and Yogyakarta, especially in Gunungkidul Regency (Yuliasari, 2022), as well as in Sleman and Bantul Regency (Nurkomar *et al.*, 2021; Prakusya, 2022).

Bantul Regency is one of the districts in Yogyakarta with high productivity of maize (BPS Bantul, 2022). The presence of fall armyworm attacks on the population of corn plants in Bantul Regency when the young leaves are still rolling causes a decrease in production by 5 - 20% (DPKP DIY, 2019). Therefore, it is necessary to control the population of *S. frugiperda* in the field (Nonci *et al.*, 2019). So far, people still use synthetic pesticides to control *S. frugiperda* populations (Bueno *et al.*, 2017). However, the continuous use of synthetic pesticides can cause resistance and resurgence in the *S. frugiperda* population (Ramadhan and Dono, 2019). Consequently, it is necessary to make efforts to control the *S. frugiperda* population without using synthetic compounds (Ramadhan and Nurhidayah, 2022), one of which is by using predatory insects (Hayati, 2021). According to Nugroho *et al.* (2021), predator survival depends on the availability of food sources. Many predators are active during the day or called diurnal. This is because the activity of predatory insects is influenced by the response to light (Subekti, 2012).

According to the Information Management and Documentation Officer of Bantul Regency (2021), Bantul Regency itself has a distinctive topography different from Sleman and Gunungkidul. About 41.62% of the area of Bantul Regency is fertile agriculture with a land use of 31.33% rice fields and 32.75% mixed gardens which can be a habitat for *S. frugiperda*. In addition, the wind speed in Bantul Regency with a range of 0.8 - 4.0 m/s supports the process of spreading predatory insects carried by wind movement (BPS Bantul, 2022). Thus, this research is important to find out other species and individual numbers of diurnal predatory insects of *S. frugiperda* in Bantul Regency as an effort to utilize predatory insects in suppressing the population of *S. frugiperda*, especially in Bantul Regency.

METHOD

This research was conducted from January 2022 to June 2023 on maize (*Z. mays*) plantations in 17 sub-districts in Bantul Regency. Sampling locations were determined using a survey method to find the presence or absence of corn fields in a village. Determination of villages as sampling locations using stratified random sampling method, where samples were taken from 17 sub-districts in Bantul regency with two villages from each sub-district. The corn fields used were determined by purposive method to see whether there were symptoms of *S. frugiperda* infestation. One of the most common symptoms of a *S. frugiperda* infestation is the presence of holes or ragged edges on leaves. The larvae feed on the leaf tissue, creating notches or large irregular holes, especially in young plants. Moreover, abiotic parameters were measured and coordinates were taken at each sampling location. Predatory insects will be captured using a swing net and hands then put into a bottle containing 70% alcohol for preservation. Identification of diurnal predator insects obtained was observed for morphological characteristics using a stereo microscope and compared the morphology of diurnal predator insects which included mouth shape, body color, number of tarsus segments, and wing patterns of diurnal predator insects using reference books and identification journals. Data analysis used is descriptive and inferential analysis. Descriptive analysis was used to describe the species and the most abundant and least abundant of diurnal predators in Bantul Regency.

RESULTS AND DISCUSSION

Species of Diurnal Predatory Insect of *S. frugiperda* in Bantul Regency

The results of this study obtained diurnal predatory insects of *S. frugiperda* in Bantul Regency consisted of 4 orders, 6 families, and 12 species. The family of predatory insects of *S. frugiperda* with the most species members is Formicidae (5 species). Meanwhile, the families with the least number of species found as diurnal predators of *S. frugiperda* with only 1 species each include Chrysopidae, Reduviidae, Vespidae and Staphylinidae (Table 1).

Table 1. Diurnal predatory insect species of *S. frugiperda* in Bantul Regency

No	Ordo	Family	Species
1	Hymenoptera	Formicidae	<i>Diacamma rugosum</i>
			<i>Polyrhachis dives</i>
			<i>Oecophylla smaragdina</i>
			<i>Camponouss</i> sp.
			<i>Formica</i> sp.
		Vespidae	<i>Polistes</i> sp.
2	Coleoptera	Coccinellidae	<i>Menachilus sexmaculatus</i>
			<i>Verania lineata</i>
			<i>Exochomus nigripennis</i>
		Staphylinidae	<i>Paederus fuscipes</i>
3	Nueroptera	Chrysopidae	<i>Chrysop</i> sp.
4	Hemiptera	Reduviidae	<i>Sycanus</i> sp.

The predatory insect species of *S. frugiperda* in this study were found to be from the Formicidae family. Many members of this family were found to be predators of *S. frugiperda* because predatory ants have a wide range of abilities in their family members (Haneda and Yuniar, 2015). Predatory ants have pheromone fluids to facilitate communication with their colony members when searching for prey (Hasibuan, 2020). One of the prey of predatory ants is *S. frugiperda* larvae (Nonci *et al.*, 2019). The larvae of *S. frugiperda* have a habit of hiding in corn leaf rolls (Prasanna *et al.*, 2018). This is not a barrier for predatory ants to find *S. frugiperda* larvae because predatory ants are characterized by slender bodies and strong jaws. There were two species of the Formicidae family in this study, namely *D. rugosum* and *P. dives*. Both types of predatory ants tend to be able to move throughout the year or in two seasons, namely dry and rainy so that *D. rugosum* and *P. dives* can be found in this study which was carried out in the rainy season.

Apart from the Formicidae family, other species of diurnal predatory insects found in this research were *Chrysopa* sp. from the Chrysopidae family and *Sycanus* sp. from the Reduviidae family. The two types of insect predators were found because the research was conducted in the rainy season and it is known that *Chrysopa* sp. tends to prefer high humidity conditions rather than low humidity (Mawaddah, 2020) and *Sycanus* sp. in the rainy season has a food source or prey, namely larvae from the Lepidoptera Order such as *Pteroma* sp. and *S. litura* (Wardani N and Eka CL., 2016; Marwoto and Pandjaitan, 2017) whose nest habitat is around the side location, namely coconut trees, cassava trees, and chili plants (Wardani N and Eka CL., 2016; Marwoto and Pandjaitan, 2017).

Abundance of Insect Predator of *S. frugiperda* in Bantul Regency

The results of this study showed that the species of diurnal predatory insects of *S. frugiperda* in Bantul Regency found the most individuals in this study were *Menochilus sexmaculatus* (109 individuals) and *Verania lineata* (107 individuals). While the species of diurnal predators of *S. frugiperda* that were found the least in this study were *Formica* sp. and *Sycanus* sp. with five individuals each (Table 2).

Table 2. Individual number of diurnal predatory insects of *S. frugiperda* in Bantul Regency

Species	Number of Individual (individual)
<i>Diacamma rugosum</i>	22
<i>Polyrhachis dives</i>	18
<i>Oecophylla smaradigna</i>	9
<i>Camponotus</i> sp.	12
<i>Formica</i> sp.	5
<i>Polistes</i> sp.	41
<i>Menochilus sexmaculatus</i>	109
<i>Verania lineata</i>	107
<i>Exochomus nigripennis</i>	77
<i>Paederus fuscipes</i>	21
<i>Chrysopa</i> sp.	12
<i>Sycanus</i> sp.	5

The highest number of individuals of diurnal predatory insects of *S. frugiperda* found in this study were *M. sexmaculatus* and *V. lineata* (Figure 1). *Menochilus sexmaculatus* is one type of the Coccinellidae family that acts as a predatory insect pest of several types of vegetable crops or agricultural crops (Udiarto *et al.*, 2012; Efendi, *et al.*, 2017). In general, the presence of *M. sexmaculatus* was widespread in various regions (Jagadish *et al.*, 2010; Efendi *et al.*, 2017). The female imago of *M. sexmaculatus* was able to produce high eggs ranging from $\pm$ 100-200 eggs

(Udiarto *et al.*, 2012). In addition, the imago of *M. sexmaculatus* has long survival and a high level of prey seeking (Udiarto *et al.*, 2012). Therefore, the high prey-seeking ability with the harmonious presence of prey around its habitat allows *M. sexmaculatus* imago to be found in this research. In addition, the preference of plant species as a living habitat of *M. sexmaculatus* such as chili plants, peanuts, long beans, or corn plants themselves which also support the habitat of prey from *M. sexmaculatus* was found. Some of the prey of *M. sexmaculatus* including eggs and larvae of *S. frugiperda* (Suroto *et al.*, 2021) and aphids (Nelly *et al.*, 2015) such as *Aphis gossypii* which is preferred over other types of aphids. Based on these prey preferences, *A. gossypii* is known to have more than one type of host plant, such as chili (Efendi *et al.*, 2017), cucumber (Blackman and Eastop, 2007), tomato (Wardana, W., 2021) and potato (Putri, S. N., and Azwar, E. 2022).

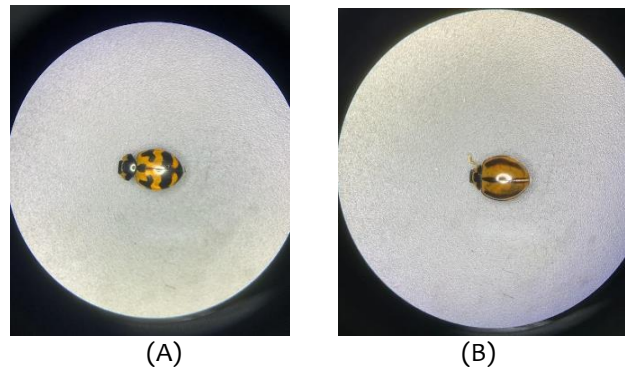


Figure 1. The Diurnal insect predator that was found most abundance in this research (A) *Menochilus sexmaculatus* and (B) *Verania lineata*

The second species of diurnal predator insect that was found in this study was *V. lineata* from the Coccinellidae family. *Verania lineata* in this study was found as many as 107 individuals. Although, it comes from the same family as *M. sexmaculatus*, the ability to produce eggs of the two types is different (Yuliasari, 2022). According to Nelly (2012), the female imago of *M. sexmaculatus* can produce ± 100 -200 eggs, while the female imago of *V. lineata* can only produce 103 eggs. According to Syahrawati and Hamid (2010), *V. lineata* is often found in rice fields. In addition, *V. lineata* was also often found around maize fields and vegetable or horticultural crops, such as long beans, cucumber and eggplant (Syahrawati *et al.*, 2013; Yudiawati and Pertiwi, 2020). In addition to *S. frugiperda* eggs and larvae, other prey of *V. lineata* include thrips, aphids, and whitefly (Inayati and Marwoto, 2015; Prayogo and Marida, 2020). Unlike *M. sexmaculatus* which has a host preference in the form of *A. gossypii*, *V. lineata* prefers whitefly (*Bemisia tabaci* Genn.) which is often found on legume plants (Udiarto *et al.*, 2012). During the study, legume plants that found around the sampling location were not abundant when compared to chili plants, causing not many whitefly to be found.

The diurnal predatory insect species of *S. frugiperda* with the least number that was found in this research of individuals were *Formica* sp. and *Sycanus* sp. (Figure 2). Each was found with only five individuals. *Formica* sp. is a type of predatory ant that seeks prey in colonies (Rizal *et al.*, 2020). The habitat of *Formica* sp. is in the litter that forms a mound as the main nest derived from a mixture of small wood, straw or old fallen leaves (Seifert, 2022). This study was conducted during the rainy season, so some sampling locations had wet to waterlogged conditions. Therefore, nesting sites for these ants were not available. According to Rizal *et al.* (2020), the presence of ants is closely related to habitat conditions. This is the reason why the number of *Formica* sp. individuals was found to be small in this study.

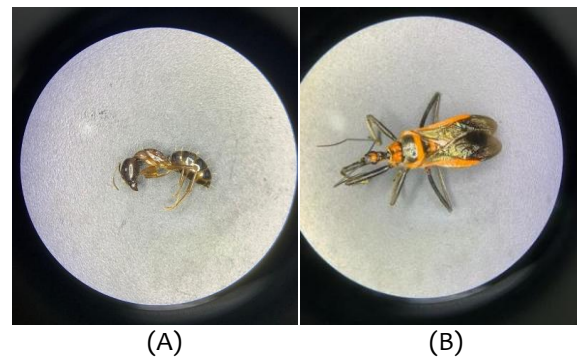


Figure 2. Diurnal predatory insect of *S. frugiperda* that was found with the least abundance (A) *Formica* sp. and (B) *Sycanus* sp.

The next diurnal predatory insect species found in the least number of individuals in this study was *Sycanus* sp. (Figure 2). *Sycanus* sp. is a species of predatory insect from the Reduviidae family (Sahid *et al.*, 2016). Imago of *Sycanus* sp. can produce 15-120 eggs, which is relatively low compared to other types of predatory insects that were found in this research (Sahid *et al.*, 2016). Eggs of *Sycanus* sp. were laid on coconut leaves (Wardani, N., and Eka, C. L., 2016). *Sycanus* sp. is a predatory insect that has a wide prey range (Jamjanya *et al.*, 2014). Some types of prey from *Sycanus* sp. include bag caterpillars (*Pteroma* sp.) pests on cassava plants (Sahid *et al.*, 2016), *Crociodolomia pavonana* Fabr. pests on cabbage plants (Sudiarta *et al.*, 2020), *Tenebrio molitor* L. pests on warehouse products (Sahid *et al.*, 2016), *Plutella xylostella* pest on cabbage crops (Yuliadhi, 2017), *Setora nitens* Walker pest on oil palm plants (Rustam *et al.*, 2016), and including *S. frugiperda* or *S. litura* larvae (Wardani, N., and Eka, C.L., 2016). However, of the above plants that used as the prey habitats of *Sycanus* sp., only plants such as chili peppers and coconut trees were found around sampling area. Meanwhile, the prey preference of *Sycanus* sp. was *S. nitens* which was a pest of oil palm plants (Lubis *et al.*, 2021). In addition, the solitary prey-seeking habits of *Sycanus* sp. (Winarsah, 2016), was one of the factors addition for *Sycanus* sp. being the second diurnal predatory insect species with the least number of individuals found in this research.

In addition to the factors previously described, the abundance or absence of the number of individuals of the diurnal predatory insect of *S. frugiperda* can also be influenced by other factors. These factors were environmental factors. Environmental factors measured in this study were air temperature, air humidity, and light intensity (Table 3).

Table 3. Average of abiotic factors measured at the sampling area in Bantul Regency

District	Air temperature (°C)	Air humidity (%)	Light intensity (lux)
Banguntapan	33.02	67.67	6982.67
Pleret	35.59	63.42	7928.75
Piyungan	30.45	68.50	3761.50
Sewon	31.29	65	43213.17
Jetis	31.63	75.85	45504.99
Imogiri	34.68	56.65	104771.65
Srandakan	28.1	88.8	13468.15
Sanden	34.72	61.32	52575
Kretek	36	51.5	134680
Pundong	27.83	95.85	6368.17
Bambamlipuro	28.08	95	19562.5
Sedayu	22.04	98.65	11660.5
Pajangan	28.61	99	34001.67
Pandak	25.60	93.67	27644.17
Bantul	32.53	90.17	76183.34
Kasihan	25.17	84.09	46901.67

District	Air temperature (°C)	Air humidity (%)	Light intensity (lux)
Dlingo	27.59	79.67	28449.67

The air temperature and humidity measured in this study had an average air temperature range of about 22.04 - 36°C, air humidity 51.5 - 98.65% and light intensity 3761.495 - 104771.65 lux. According to Singh *et al.*, (2014), *M. sexmaculatus* has an optimal temperature range of 20 – 30°C, an air humidity range of 66 - 85% (Saleem *et al.*, 2014) and a light intensity of 2140 lux - 6700 lux (Sundari, 2018). Thus, the air temperature, air humidity and light intensity measured in this study are factors that support the survival and also the discovery of the highest number of individuals of the diurnal predatory insect *M. sexmaculatus* in this research.

Then, the next species of diurnal predatory insect that was found in this research was *V. lineata*. According to Syahrawati *et al.* (2021), *V. lineata* can be found in the temperature range of 26.7 - 29.2°C, air humidity of 70.6 - 80.9% and light intensity of 2140 - 6700 lux (Sundari, 2018). The results of abiotic factor measurements in this study obtained an air temperature range of 21.8 - 31.15°C, air humidity range of 52 - 87.78% and light intensity of 3761.50 - 104771.65 lux (Table 3). The average results of abiotic factor measurements at this research location support the survival of *V. lineata* and cause the second highest number of individuals in this study.

Diurnal predatory insects of *S. frugiperda* that were found to have the least number of individuals in this research were *Formica* sp. and *Sycanus* sp. According to Saputra *et al.* (2020), ants in the tropics, including *Formica* sp., have an optimal air temperature range in the range of 30.87 - 35°C with the lowest air humidity of 58% and light intensity of 439000 - 96000 lux (Karniati, 2022). So that the air temperature and humidity measured at the research location were less supportive of the survival of *Formica* sp. This is a possible factor in the discovery of the least number of individuals of *Formica* sp., which is only 5 individuals in this research.

The next species of diurnal predatory insect found with the least number of individuals in this research was *Sycanus* sp.. According to Sahid *et al.* (2016), *Sycanus* sp. can be found in the air temperature range of 24 - 28°C with an average air humidity of 59 - 90% and light intensity in the range of 2000-7500 lux (Parlina, 2021). Therefore, the air temperature and humidity measured at the sampling location were less supportive of the survival of *Sycanus* sp. This can be the cause of the number of individuals of *Sycanus* sp. found being minimal in this research.

CONCLUSION

The conclusions of this research were the species of diurnal predatory insects of *S. frugiperda* were obtained in Bantul Regency, consisted of 12 species. The diurnal predator insect species of *S. frugiperda* that was found with the most abundant number of individuals was *M. sexmaculatus*, while the diurnal predator insects that was found with the least number of individuals were *Formica* sp. and *Sycanus* sp.

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