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Insect predator of *spodoptera frugiperda* J. E. Smith in Sleman and Gunungkidul regency, Indonesia

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ABSTRACT

This research was conducted to identify and found the abundance of predatory insect species of *S. frugiperda* in Sleman and Gunungkidul Regencies, Yogyakarta Province, Indonesia. This research was conducted in June 2021 - March 2022 on corn plantations in Sleman and Gunungkidul Regencies. Determination of the sampling location was determined by *stratified random sampling*. Corn land used in sampling was determined by *purposive*. Insect predator caught by using sweeping net and hand picking. The results showed that there are 3 orders, 8 families, and 16 species of insect predators. 3 orders of the insect predators that found in the Sleman and Gunungkidul Regencies were Coleoptera, Hymenoptera, and Hemiptera. Insect predator families that found in Sleman dan Guungkidul Regencies were Coccinellidae, Carabidae, Staphylinidae, Formicidae, Vespidae, Pentatomidae and Reduviidae. Insect predators species that was most commonly found was *Menochilus sexmaculatus* with 467 individuals and the least was *Sycanus* sp. with 1 individual. The conclusion of this study is that there were 16 species of predators from *S. frugiperda* in Sleman and Gunungkidul Regencies. Practical implications of this research were the insect predators that found in Sleman and Gunungkidul Regencies can be used to maintain the population of *Spodoptera frugiperda* in two regencies.

Contribution/Originality: This research was the first research that study the species predatory insect of *Spodoptera frugiperda* in Indonesia, especially in D.I. Yogyakarta, specifically in Sleman and Gunungkidul Regencies.

1. INTRODUCTION

The corn armyworm (*Spodoptera frugiperda*) is an insect native to the United States that has spread to the Asian continent, including Indonesia. *Spodoptera frugiperda* was originally found in the Pasaman area, West Sumatra [1] and has spread to Bandung, Garut, Sumedang [2] to Sleman, Gunungkidul, Bantul, Yogyakarta [3]. Armyworm caterpillars have several host plants, especially from the Graminae group such as corn, rice [4] cotton [5] and sorghum [6]. *Spodoptera frugiperda* had causes losses to corn crops of 8.3 - 20.6 million tons per year with an economic loss value of US $ 2.5 - 6.2 billion per year on the African Continent and Europe.

Control of these caterpillars has been carried out to minimize yield losses from corn plants. So far, armyworms have been controlled using synthetic pesticides [7, 8]. Originally there were natural enemies that have been found to be able to control this pest population in nature [9]. Natural enemies found in nature can disrupt species

diversity and populations due to the use of insecticides [10]. One of the natural enemies of *S. frugiperda* found in nature is from the predator class [11]. Several armyworm predators that have been found include *Lycosa* sp., and *Coccinella transversalis* Thunberg [3]. In addition, research in West Lombok conducted by Jannah, et al. [12] found 8 species of predatory insect of *S. frugiperda*, including *Cheilomenes sexmaculata*, *Coelophora inaequalis*, *Verania lineata*, *Polistes gallicus*, *Polyrhachis dives*, *Chrysopa* sp., and *Lycosa* sp.

2. MATERIAL AND METHODS

This research was conducted in June 2021 - May 2022 on corn (*Z. mays*) plantations in 17 sub-districts of Sleman and 18 sub-district of Gunungkidul Regency. Identification of predators was carried out at the Ecology and Systematics Research Laboratory, Faculty of Applied Science and Technology, Ahmad Dahlan University. The materials used in this study were samples of predatory insects from the field and 70% alcohol.

The methods that used in this research were:

2.1. Determination of the Sampling Location

Determination of the location of this sample is determined by a random stratified method. Samples were taken from 17 sub-districts in Sleman and 18 sub-districts in Gunungkidul Regency. Two villages were taken from each sub-district to be used as sampling locations using a random stratified method. Each village is taken one land used in predator sampling. The maize fields used in predator sampling in each village were determined using the purposive. The age of the corn plants used in this study was around 2-3 weeks old and had not yet flowered.

2.2. Sampling and Preservation

Sampling was carried out every two weeks, when sampling there is no repetition in the same land (one field for one sampling), this sampling is carried out by exploring corn plantations in Sleman and Gunungkidul Regencies by determining in advance which village and sub-district to go to by looking at maps and then tracing the streets around the village and sub-district. Samples were taken in the form of insect predators of *S. frugiperda* which were carried out mechanically using hands, *sweep nets* and tweezers. Sampling was carried out by exploring all corn plants affected by *S. frugiperda* with perforated or damaged leaves. The insect predator that obtained were put into a 50 ml plastic bottle filled with 70% alcohol to preserve the sample.

2.3. Identification of the Insect Predator

Predator sample which had been preserved in 70% alcohol then observed for its morphological characteristics. Identification was carried out by comparing morphological characters including the shape of the mouthparts, body color, number of *tarsus* on the limbs, and patterns on the wings of the predators which were obtained from books and journals Manting, et al. [13]; Ndiaye, et al. [14]; Fallahzadeh, et al. [15]; Rodríguez-Vélez, et al. [16] and Mayadunnage, et al. [17]. The species of predators that are know were then documented using a cellphone and the number of individuals was counted to find out which predators have the most and the least number of individuals.

3. RESULT AND DISCUSSION

3.1. Insect Predator of S. frugiperda in Sleman and Gunungkidul Regency

This study found 3 orders, 8 families, and 16 species of predators from *S. frugiperda*. Families with species that act as predators of *S. frugiperda were* most commonly found in the Formicidae (5 species) and Coccinellidae (4 species) families. While the families that act as predators at least are Staphylinidae, Carabidae, Reduviidae and Pentatomidae (1 species) Table 1.

Table 1. Types of predators of *S. frugiperda* in Sleman and Gunungkidul Regencies.

Ordo	Families	Species
Coleoptera	Coccinellidae	*Coccinella transversalis*
		Verania lineata
		Menochilus sexmaculatus
		Exochomus nigripennis
	Staphylinidae	*Paederus fuscipes*
	Carabidae	*Ophionea nigrifasciata*
Hymenoptera	Formicidae	*Polyrachis dives*
		Diacamma rugosum
		Odontomachus chelifer
		Dolichoderus thoracicus
		Paratrechina longicornis
	Vespidae	*Vespa* sp.
		Polistes sp.
Hemiptera	Pentatomidae	*Andralus spinidens*
	Reduviidae	*Sycanus* sp.

The most common species found as predators of *S. frugiperda* in this study came from the Formicidae Family. The Formicidae family is an insect belonging to the ant group (Order Hymenoptera). Ants are insects that are widely distributed throughout the world except in the polar regions [14]. The Formicidae family consists of 14 sub-families and based on their role in nature, 29% of ants act as predators. Predator ants are active and strong and prey on smaller insects [15]. Many members of this family are found as predators of *S. frugiperda* due to the wide range of range of its family members. In addition, ants have pheromone fluids that make it easier for their members to find prey in hidden locations [16].

Apart from the Formicidae family, many members of the Coccinellidae family were also found as predators of *S. frugiperda* in this study. Many members of the Coccinellidae family were found because around the sampling location there were plants other than corn, such as chili and rice. Both of these plants can affect the distribution of members of the Coccinellidae family [17] because these plants contain aphids. These aphids are the main prey of Coccinellidae [18].

The presence of aphids on plants around the corn field will make members of the Coccinellidae family come to prey on these aphids. The more aphids found on plants around the corn field, the more species and abundance of Coccinellidae members found in that location [19]. This is in accordance with the opinion of Rain, et al. [20] that the diversity and abundance of predatory Coccinellidae depends on the presence or absence of aphids at that location. Apart from surrounding plants, aphids can also be found on corn plants [21, 22].

The presence of aphids on corn plants can become an alternative prey if the population of aphids found on surrounding plants has decreased [18]. The advantage of Coccinellidae members who prey on aphids on corn plants, besides getting prey in the form of aphids, they can also prey on the first and second instar larvae of *S. frugiperda* found on these corn plants. This is in accordance with research from Nurkomar, et al. [3] who stated that apart from preying on aphids, predatory Coccinellidae found on corn plants also prey on the early instar larvae of *S. frugiperda*. This opinion is in line with the statement of Malo and Hore [23] which states that the Coccinellidae family is a predator of the eggs and young instar larvae of *S. frugiperda*.

3.2. Abundance of Insect Predator of S. frugiperda in Sleman and Gunungkidul Regencies

The results obtained in this study indicate that the predators of S. frugiperda that were found mostly on corn, namely *M. sexmaculatus* with a total of 467 individuals and the next is *V. lineata* with 301 individuals. Meanwhile, the fewest predators of *S. frugiperda* found on corn, namely *Sycanus* sp. with only one individual Table 2.

Table 2. The number of individual predators of *S. frugiperda* found on corn plants in Sleman and Gunungkidul Regencies

Species	Number of individuals
Coccinella transversalis	87
Verania lineata	301
Menochilus sexmaculatus	467
Exochomus nigripennis	32
Paederus fuscipes	50
Ophionea nigrifasciata	2
Polyrachis dives	186
Diacamma rugosum	14
Odontomachus chelifer	16
Dolichoderus thoracicus	3
Paratrechina longicornis	5
Vespa sp.	9
Polistes sp.	21
Andralus spinidens	10
Sycanus sp.	1

Menochilus sexmaculatus was most commonly found as a predator of *S. frugiperda* in this study because this beetle has a wide range of prey [17]. Apart from aphids, *M. sexmaculatus* is also known to prey on the whitefly *Bemisia tabaci* Setiawati, et al. [24] and *Diaphorina citri* [25]. Among the prey that has been mentioned, *M. sexmaculatus* has a preference for *Aphis gossypii*. In addition, the large number of chili plants found around the study site allows for an abundance of individuals of *A. gossypii* as prey for *M. sexmaculatus*. The more prey available, the higher the abundance of predators following the abundance of their prey [26]. *Menochilus sexmaculatus* will certainly prefer prey populations that are always available compared to prey that are only available at certain times [26].

Apart from having a wide range of prey, another factor that causes the high population of *M. sexmaculatus* is because it's a voracious predator [17]. The first to fourth instar larvae of *M. sexmaculatus* were able to prey on 347 *A. gossypii* within 5 days and one adult of *M. sexmaculatus* was able to prey on 270 prey per day with the same type of prey. The predatory insect species of *S. frugiperda* that had the second highest number of individuals in this study was *V. lineata*. The high population of this beetle is because *V. lineata* does not only prey on *S. frugiperda* larvae. *Verania lineata* also known to prey on the brown planthopper (*Nilaparvata lugens*) [27]. These planthoppers are commonly found in rice plants [28]. However, the rice plants around the study site entered the harvest season, so the population of *N. lugens* was not abundant. This is why *V. lineata* also switches to other prey if its main prey is not found. *Verania lineata* also preys on aphids, thrips, and whitefly. Aphids preyed upon by *V. lineata* are *A. gossypi* and *A. craccivora* that in legumes plant. The legume plants found around the research site are not as abundant as chili plants. This is why the population of *V. lineata* is not as large as *M. sexmaculatus*.

Apart from being influenced by other prey preferences, the Coccinellidae family can be found in abundance because they are able to produce a large number of eggs. An adult female of *M. sexmaculatus* can produce as many as 100-200 eggs during her life cycle, while an adult female of female *V. lineata* is able to produce as many as 103 eggs during her life cycle. Meanwhile, for the other two Coccinellidae species, the number of individuals was not abundant because an adult female of *C. transversalis* was only able to lay 100 eggs during its life cycle, and an adult female of *E. nigripennis* was able to lay 69 eggs during its life cycle. These results also support that the ability of female imago to produce eggs is the highest for *M. sexmaculatus* and *V. lineata*, so that in this study both types had the most abundant number of individuals compared to other Coccinellidae species. In addition to finding predators from *S. frugiperda* with the highest abundance of individuals, this study also found predators from *S. frugiperda* with the least abundance of individuals.

Apart from being influenced by food factors and the ability to reproduce, the abundance of predators found was also influenced by abiotic factors. The abiotic factors that influenced the number of individual insect predators of *S. frugiperda* in this study included air temperature and humidity. The air temperature and humidity measured in this

study had an average air temperature range of 21.8 – 31.15^{0}C and an air humidity range of 52 – 87.78% (Table 3). *Menochilus sexmaculatus* has a minimum temperature range of 20^{0}C, optimum temperature of 25^{0}C, and maximum temperature of 300C [29] whereas the humidity range of 66 – 85% [30]. So the temperature and humidity at the study site can support the survival of *M. sexmaculatus*. This is why the individual abundance of *M. sexmaculatus* was found to be high in this study. In contrast to *M. sexmaculatus*, *V. lineata* was also found in the average air temperature range of 21.8 – 31.15^{0}C and humidity range of 52 – 87.78%. According to Syahrawati, et al. [27] *V. lineata* can be found in the temperature range of 26.7 – 29.2^{0}C and humidity of 70.6 – 80.9% so that the temperature and humidity in the study site are able to support the survival of *V. lineata*.

Table 3. Mean abiotic factors measured at sampling locations in Sleman and Gunungkidul Regencies, Indonesia.

Regency	Sub-district	Wind velocity (m/s)	Light intencity (lux)	Air temperature (^{0}C)	Air humidity (%)
Sleman	Berbah	0	9707.5	27.05	87.85
	Kalasan	1.2	66234	28.5	53.5
	Ngemplak	0.65	1310	24.85	58.7
	Prambanan	0	4450	23.15	70.3
	Ngaglik	0.4	7402.5	25.05	61.65
	Pakem	0.2	15588	25.6	63
	Cangkringan	0.7	2290	26.45	52
	Sleman	0.2	5839.5	25.5	70.85
	Turi	0.2	3199	25.05	77
	Mlati	0.2	2079.3	27	63.1
	Tempel	0.9	19327	29.2	67.3
	Depok	0.65	37578.5	30.3	53.15
	Moyudan	0.2	6857	21.8	75.65
	Minggir	0.4	21780	27.2	74
	Seyegan	0.4	23292.5	29.05	61.8
	Godean	1.35	11163.5	31.15	52.65
	Gamping	0.05	5108	29.1	53.2
Gunungkidul	Patuk	0.1	86595.5	30.51	62.67
	Playen	0.12	16879.17	28.27	73
	Paliyan	0.03	52630	29.16	81.34
	Panggang	0.08	9531.83	33.05	63.67
	Gedangsari	0.52	133333,33	31.55	64.67
	Wonosari	0.39	401696.67	32.08	63.56
	Saptosari	0.13	30951.83	27.55	70
	Nglipar	0.03	2033	30.77	64.67
	Semin	0.2	12937.17	26.29	72.67
	Ngawen	0.93	57865	29.56	67.5
	Karangmojo	0.62	46592,11	29.46	66.56
	Semanu	1.23	14831.67	28.40	55.84
	Tepus	0.9	87195	30.18	54
	Tanjungsari	1.71	80916.67	32.05	54.34
	Purwosari	0.62	68396.63	30.36	50
	Ponjong	1.32	4204.5	24.92	94.34
	Girisubo	0.02	11270.33	26.15	91.67
	Rongkop	0.12	182316.67	33.87	51.5

4. CONCLUTION

The insects predator species of *S. frugiperda* found in this research consist of 16 species divided into 3 orders. The predatory type of *S. frugiperda* with the highest number of individuals was *Menochilus sexmaculatus*. While the least number of individuals is *Sycanus* sp.

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