Composition and Abundance of Above Ground Insects in Areas Affected by Ant Population Outbreak

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Abstract. An ant outbreak occurred in an area of Pageraji Village, Cilongok District, Banyumas Regency, at the end of 2020; this disrupted resident activities and caused economic losses. This preliminary study reports the composition and abundance of ground insects in the region of the ant attack. The insects are a community resource in that they are important members of the food web. The research was conducted from April to May 2021 in guava, long bean, and cassava fields. We employed a random sampling technique. In each field, we set a diagonal transect line and marked 10 equidistant sampling points, at each of which we set three pitfall traps for 3 days. The long bean field yielded the most insects (489 individuals from 15 families), followed by the guava field (318 individuals from 14 families) and the cassava field (240 individuals from 14 families). The highest diversity index (H') was in the long bean field (1.86) followed by the cassava (1.80) and guava (1.65) fields. The evenness indexes were 0.43, 0.43, and 0.37 for the cassava, long bean, and guava fields, respectively. Detrivores were the most common insects (46%), followed by predatory (44%), herbivorous (9%), and parasitoid (1%) insects. Of the predatory insects, 90% were in the family Formicidae (ants); of the 46% detritivorous insects, 93% were in the order Collembola.

Keywords: abundance · ants · composition · ground insects · guild

1 Introduction

Ants are social colonial insects and are the dominant animals of the tropics. Ant habitats vary widely from deserts, savannas, and forests, to human habitations (Habibullah et al., 2021). Ants are an important component in the ecosystem with slavery as ecosystem engineers (Widhiono et al., 2017).

When the population is so high that an outbreak occurs, ants can invade settlements, disrupting human activities and causing economic losses (Habibullah et al., 2021). Ants negatively affect human activities via their eating and nesting habits and aggressiveness, and may also carry pathogens (Norasmah et al., 2006). A region of Pageraji Village, Cilongok District, Banyumas Regency, was affected by an ant outbreak at the end of

S. B. Sulistyo et al. (Eds.): ICSARD 2022, ABSR 30, pp. 431–438, 2023.
https://doi.org/10.2991/978-94-6463-128-9_42

2020. Initially, the ants were found in agricultural and plantation areas but then they invaded homes and became very disturbing.

When seeking to explain such an outbreak, information on the composition and abundance of fauna in the region is required. In particular, the composition and abundance of ground surface insects are important; these insects are a community resource that plays a key role in the food web. Insects maintain ecosystem balance/stability because they exhibit even distributions at the trophic level (Kinasih et al., 2017). Understanding the relationship between ecosystem complexity and stability is an important key to maintaining the balance and conservation of ecosystem services (Landi et al., 2018). Thus, we determined the composition and abundance of soil surface insects on land infested with ants in Pageraji Village, Cilongok District, Banyumas Regency.

2 Materials and Methods

2.1 Location Description

The research location is an area of Pageraji Village, Cilongok District, Banyumas Regency, Central Java, with both lowland and highland topography. The land consists of guava, long bean, and cassava plantations that are managed conventionally. The research was conducted from April to May 2021.

2.2 Research Methods

We used a random sampling technique along diagonal line transects in fields. On each transect, 10 equidistant sampling points were chosen, and three pitfall traps were installed at each point for 3 × 24 h.

2.3 Procedure

Pitfall traps containing 1/3 cup of 96% (v/v) alcohol were placed in the ground with the surfaces level with the ground under the roof of each sampling point. After 3 days, all trapped insects were transferred to sample bottles and taken to the Entomology and Parasitology Laboratory, the Faculty of Biology, Universitas Jenderal Soedirman. The insects were separated from other materials and organisms under a stereomicroscope and identified to the family level following Triplehorn and Johnson (2005), Chung (2003), Belinger et al. (2006), and Suhardjono et al. (2012).

2.4 Data Analysis

ANOVA was used to analyze the abundances of soil surface insects in each field at error rates of 10% and 20%. Insect diversity was calculated using the Shannon-Wiener diversity index, and evenness was calculated employing the evenness index (Maguran, 1988) as follows:

$$H' = -\sum (pi)(\ln\ pi) \quad (1)$$

Information:

H': Diversity index
Pi: The proportion or number of families relative to i

Criteria:

H > 3: high diversity index
1 < H < 3: medium diversity index
H < 1: low diversity index

$$E = H'/\ln S \tag{2}$$

Information:

E: Evenness index.
H': Diversity index.
S: Number of species (in this case families).

Criteria:
Evenness ranges to E = 1. If E = 1, there is no dominant species.

3 Results and Discussion

We found six insect orders in the guava, long bean, and cassava fields. All three fields yielded Coleoptera, Diptera, Hymenoptera, and Collembola. Hemiptera were found in the guava and long bean fields but not in the cassava field; Orthoptera were found in only the cassava field. The guava and cassava fields yielded insects of 14 families, and the long bean field included insects of 15 families. The insect families included Nitidulidae, Melandrydae, Staphylinidae, Carabidae, Trichoceridae, Sciaridae, Mydidae, Formicidae, Entomobryidae, Isotomidae, Paronellidae, and Hypogastruridae. Families Eulophidae and Aphididae were found only in the guava and long bean fields; the family Gryllidae was in only the cassava field; and the family Sminthuridae was in the long bean and cassava fields. ANOVA revealed that the abundances in the three fields differed significantly. The highest number of individuals was obtained from the long bean field (489), followed by the guava field (318), and the cassava field (240). The family with the highest number of individuals was the Formicidae with a total catch in the three fields of 417 (171 in the guava field, 129 in the long bean field, and 117 in the cassava field; Table 1).

The population of ground surface insects is influenced by habitat conditions such as temperature and humidity, food availability, and the presence of natural enemies. The Formicidae (ant) family was the most abundant and most evenly distributed in the three fields. Similar results were reported by Basna et al. (2017), who found that the Formicidae dominated the three habitat types of the Gunung Tumpa Forest Park, North Sulawesi. Kinasih et al. (2017) showed that the Formicidae predominated on Mount Geulis Sumedang. Suin (2018) found that the Formicidae could constitute 70% of all ground insects; the numbers can be very large. Ants are very diverse and can be very

abundant; they are highly mobile and colonize readily. Ant nests are found in soil, litter, and trees (Campos et al. 2007; Heuss et al., 2019). The land in the ant-infested area of Pageraji Village is dry. Way and Khoo (1992) found that ants prefer dry land that does not flood. Ants forage mainly under bushes and other herbaceous plants (Lindsey and Skinner, 2001), predominantly older plants (Puntitila 1996; Liu et al., 2013).

In our study, the second most abundant family in the three fields was the Hypogastruridae (258 individuals), which are detrivores of the order Collembola. These insects increase soil fertility and trigger microbial activity by decomposing organic matter and feeding on fungi. They serve as indicators of changes in soil conditions, balance the soil fauna in terms of pollinators and predators, and affect soil respiration and structure (Suhardjono et al., 2012, Muturi et al., Ponge et al., 2003). The Collembola balance the other soil fauna by maintaining predators (their natural enemies) when the insect pest population (herbivores) is low (Haneda and Asti, 2014).

The family Eulophidae (order Hymenoptera) was of low abundance (1%) and not found at all in the cassava field because these insects are not always above the ground. In addition, herbivore insects such as those in the families Melandrydae, Sciaridae, Gryllidae, and Aphididae, were scarce (9%). The abundance of parasitoid insects is generally influenced by the availability of herbivorous insects as hosts (Larasati et al., 2013). The family Gryllidae (order Orthoptera) was found only in the cassava field. These insects live in groups and appear only around June–July and November–December (Rufies 2012).

In the order Coleoptera, the families Carabidae and Staphyllinidae are predatory and the Nitidulidae and Melandryidae are herbivorous. The nocturnal Carabidae are termed ground beetles because they live on or near the ground; during the day, they usually hide under leaves, rocks, or plant stems. The family Staphylinidae (the wandering beetles) has an elongated and slender body and is usually recognized by the very short elytra. The family Nitidulidae are herbivores that feed on plant fluids and their bodies are generally dark and slightly shiny. Insects in this family perch on plant bark and tear the bark to access liquid. The family Melandryidae includes herbivores with round, elongated bodies that are dark and shiny (Triplehorn and Johnson, 2005).

Of the order Diptera, we found the families Trichoceridae, Mydidae, and Sciaridae. Trichoceridae flies are of medium size with long legs similar to those of Tipulidae flies; the difference is that the Trichoceridae have ocelli. The larval stage usually feeds on rotting vegetables. The Mydidae family, often termed Mydas flies, have large and long bodies (about 55 mm) and long antennae with four segments. The larval stages often live in wood. Both the adult and larval stages are predatory. The family Sciaridae is small (1.5–3 mm), and members have dark bodies. Sciarid larvae generally live in litter, soil, fungi, and rotting wood; some species live in colonies and some are pests of mushroom cultivations (Triplehorn and Johnson, 2005).

The diversity index (H') in the long bean field was 1.86, followed by the cassava field at 1.80 and the guava field at 1.65. The diversity of soil surface insects was thus moderate. The evenness index (E) of the cassava and long bean fields was 0.43, and that of the guava field was 0.37. An E below 1 indicates the presence of a dominant type.

Based on their ecosystem roles, detrivores were the most common (46%), followed by predatory insects (44%), herbivorous insects (9%), and parasitoid insects (1%) (Fig. 1).

Table 1. Number of families, individuals, diversity index (H'), and evenness index (E) of insects ground level on three fields

No.	Ordo	Family	Role (guild)	Guava Field (individual)	Long bean Field (individual)	Cassava Field (individual)
1	Coleoptera	Nitidulidae	Herbivore	24	6	3
2		Melandrydae	Herbivore	15	3	3
3		Staphyllinidae	Predators	6	6	9
4		Carabidae	Predators	3	6	3
5	Diptera	Trichoceridae	Detrivore	3	21	9
6		Sciaridae	Herbivore	3	9	3
7		Mydidae	Predators	3	6	3
8	Hymenoptera	Eulophidae	Parasitoid	3	3	0
9		Formicidae	Predators	171	129	117
10	Orthoptera	Gryllidae	Herbivore	0	0	18
11	Hemiptera	Aphididae	Herbivore	3	9	0
12	Collembola	Entomobryidae	Detrivore	3	27	6
13		Isotomidae	Detrivore	42	45	12
14		Paronellidae	Detrivore	9	30	6
15		Hypogastruridae	Detrivore	30	186	42
16		Sminthuridae	Detrivore	0	3	6
	Number of Families			14	15	14
	Number of Individuals			318	489	240
	H'			1.65	1.86	1.80
	E			0.37	0.43	0.43

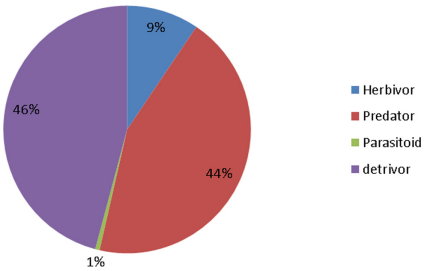

Fig. 1. Composition of ground insects based on their ecosystem functions.

The detritivorous insects (46%) were predominantly those of the order Collembola (93%), mainly the Hypogastruridae family (57.72%). The Collembola group is a soil

mesofauna with a rather wide distributional pattern, and is often abundant in terrestrial ecosystems because of an ability to tolerate various habitats and conditions. The Hypogastruridae are widely distributed in the tropics and subtropics (Verma and Paliwal, 2010, Suhardjono et al., 2012). Maarif et al. (2014) and Indriyati and Lestari (2008) reported that detrivores of the order Collembola predominated in their research areas. Suhardjono et al. (2012) found that the Collembola is a periodic group; members spend their entire life cycle in the soil.

The predatory insects (44%) that we found were dominated by ants (Formicidae) (90%). This family is very mobile, very social, and forms colonies; ant numbers can become very high (Campos et al., 2007). Many predators were reported by Indriyati and Lestari (2008) in fallow, organic rice fields; the proportion of predators was higher than that of herbivores. It was suggested that the Collembola not only engaged in detritivore activity but also maintained the lives of predatory arthropods when the numbers of the usual prey herbivores were low in rice fields. The association between Collembola and ants may be commensal. Ants store food in their nests, in which colonies of bacteria and fungi develop; Collembola come to anthills to consume the bacteria and fungi (Sleptzova and Reznikova 2006). This aside, the ant abundance in Pageraji Village may reflect poor sanitation, abundant food associated with production of coconut sugar, and the presence of the ant-associated Aphididae family.

4 Conclusion

The soil-surface insects in the area affected by ants were of six orders: Coleoptera, Diptera, Hymenoptera, Collembola, Hemiptera, and Orthoptera. This included 16 families: Nitidulidae, Melandrydae, Staphyllinidae, Carabidae, Trichoceridae, Sciaridae, Mydidae, Formicidae, Entomobryidae, Isotomidae, Paronellidae, Hypogastruridae, Sminthuridae, Eulophidae, Aphididae, and Gryllidae. The highest insect abundance was in the long bean field (489 individuals), followed by the guava field (318) and cassava field (240). The highest H' was that of the long bean field (1.86), followed by the cassava field (1.80) and guava field (1.65). The E of the cassava and long bean fields was 0.43, and that of the guava field 0.37. Based on the ecosystem functions, detritivorous insects were the most abundant (46%), followed by predatory insects (44%), herbivorous insects (9%), and parasitoid insects (1%). Of the 44% of predatory insects, 90% were Formicidae (ants); of the 46% of detritivorous insects, 93% were of the order Collembola. It may be that the abundances of Collembola and ants are in some way correlated; further work is required, as are future studies of the feeding webs of ecosystems affected by ant infestations.

Acknowledgments. We thank the Institute for Research and Community Service of Universitas Jenderal Soedirman.for funding under contract number T/1178/UN23.18/PM.01.01/2021. We thank the Head of Pageraji Village, Cilongok District, Banyumas Regency, and the entire community of RT 03/RW 03 Pageraji Village, Cilongok District, Banyumas Regency, for allowing us to conduct this research.

Authors' Contributions. Trisnowati Budi Ambarningrum contributed to conceptualization, data analysis, investigation, methodology, supervision, validation, visualization, writing (original draft preparation). Imam Widhono contributed to data analysis & writing (review & editing). Trisno Haryanto contributed to data analysis, investigation, resources, writing (review & editing). Hery Pratiknyo contributed to project administration & writing (review & editing). Fathimah Nurfithri Hashifah contributed to writing (review & editing).

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