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Diversity of Diurnal Beetles from Housing and Non-Housing Areas in Ahmad Dahlan University of Banguntapan, Yogyakarta

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ABSTRACT

Beetles are insects that have the highest species diversity and abundance of individuals and have various roles in the ecosystem. The presence of insect plays important role. If the diversity of insect in high level, it can be said that the environment is balanced. Beetle has a big role to ecosystem sustainability, because beetle had a diurnal activity. This study aims to compare diversity, abundance, and dominance of diurnal beetles between housing and non-housing area around UAD. We did a survey using pitfall trap in four areas and then the sample is taken to the laboratory for identification process. The highest beetle diversity index value was in the rice fields of Banguntapan District, DIY, which was 2,302, while the lowest beetle diversity index value was on campus 4, which was 0.725. The beetle species with the highest species abundance was *Gonocephalum* sp., while the beetle with the lowest species abundance was *Bradycellus nigrinus*, *Cassida circumdata*, *Aspidomorpha sanctaecrusis*, *Verania lineata,* and *Onthophagus* sp. The dominant beetle was *Gonocephalum* sp., while the less dominant beetle was *B. nigrinus.* The impact from this study is to determine environmental conditions based on dominant beetles. This research can be used to monitor the ecosystem health.

Keywords: built land, *Gonocephalum* sp., land use change, non-built land, *pitfall trap*

INTRODUCTION

Insects are generally a group of animals that have six limbs (Hexapoda), where the body is composed of three main parts, namely the head, thorax and abdomen (Purwantiningsih et al., 2012). Insects consist of 29 orders and 950,000 species. The insect order with the highest species diversity and individual abundance is the beetle (Coleoptera). Beetles play a very important role in ecosystems because they have various ecological roles, such as herbivores, predators, scavengers and decomposers (Rahayu et al., 2017). Another role of beetles is a pollinator. Beetles are the most dominant pollinating agent, which is pollinating 88.3% of the total types of flowering plants. The distribution and abundance of beetle species is influenced by several factors, such as rainfall (Nuriyanti et al., 2017), activity, and beetle development (Umboh *et. al.*, 2013) (Umboh et al., 2018). In addition to the factors already mentioned, other factors such as humidity also affect the ability to lay eggs and the growth of beetles. Research on the diversity of beetle species in rice fields

conducted by TAURUSLINA A, (2015) showed that *Verania lineata* is a type of beetle that has the potential to be used as a natural enemy of brown planthopper pests that attack rice, because this type of beetle is a predator that eats leafhoppers. Another study conducted by Usyati, *et. al.* (2015) Usyati et al.(2016) he stated that the type of *Verania lineata* was routinely fed 5 brown planthoppers for each treatment of Rojolele rice plant testing.

Urbanization caused habitat loss and fragmentation. Habitat fragment, such as forest patches, in developed landscapes are usually small and irregularly shaped. Thus, forests in the landscape are experiencing urbanization are becoming increasingly dominated by edge habitats, indicating highly environmental conditions changes that can significantly affect the distribution of organism, such as ground beetles (Coleoptera: Carabidae) (Davis & Gagné, 2018).

Beetle diversity habitat was threaten by urbanization and the sprawl of agricultural areas. In addition, climate change may cause shifts in geographical distribution and community composition. Study sites were established in four local land-use types: forests, grasslands, arable sites, and settlements, embedded in near-natural, agricultural, or urban landscapes. The result from this research show that abundance and species density of dung-visiting beetles (Scarabaeidae) were negatively affected by agricultural land use at both spatial scales. Whereas the diversity at the local scale was negatively affected by settlements and on a landscape scale equally by agricultural and urban land use (Englmeier et al., 2022). Land-use intensification, as a consequence of the constantly growing global human population (Seto et al., 2011), comes along with more intensive management techniques and the transformation of natural habitats to agricultural and urban areas, which may negatively affect dung beetle abundances (Sánchez-Bayo & Wyckhuys, 2019).

Changes in abundance, number of species, and community composition, e.g., by habitat loss, may affect community net-works and stability (Neff et al., 2021). Climate, moreover, might also moderate the structure and dynamics of networks (Classen et al., 2020). Community networks can be described by the structure and density of interaction links, and allow, inter alia, drawing conclusions about the specialization ofindividual species or communities (Neff et al., 2021), for instance about the specialization of dung beetles on dung types.

Research on the diversity of beetle species at housing and non-housing areas in Ahmad Dahlan University (UAD), Banguntapan has never been carried out. Study about insect diversity have some important role in environment because if the diversity of an insect in high level, the stability of the ecosystem is also higher, this is related to the food chain and ecological processes such as predation, parasitism, competition, symbiosis, and predation in the ecosystem is increasingly complex and varied, so it has the opportunity to cause balance and stability. This research was conducted on diurnal beetles caused by the method using pitfall trap that have been placed in the morning and taken in the afternoon, so the dominant caught beetles are diurnal beetles. The occurrence of land use change from non-built land (paddy fields and vacant land) to built-up land (UAD, Banguntapan campus and housing) will certainly affect the diversity, abundance, and dominance of the beetles themselves. The existence of development from non-built land (paddy fields and vacant land) to built-up land UAD, Banguntapan campus and housing) makes this research

important to do, considering that beetles have various roles in nature and as an effort to record the types and abundance of beetles in the area of campus 4 UAD, rice fields, housing, and vacant land in Banguntapan District, DIY. Seeing the massive construction of campus 4 UAD, it is possible that it will affect the diversity of species and abundance of beetles on the land.

METHOD

Location Survey, Determination of Plots and Preparation of Material Tools

The survey was located in 4th Campus of Ahmad Dahlan University which surrounded by rice fields, vacant land, and housing. Sampling location has determined using purposive sampling method and Notoatmodjo, (2010) criteria that each plot must have an area of 35 x 50 m^2 and not arid. by determining the sampling location using the *purposive mpling method,* namely the determination of the location of the sample based on a certain consideration (Notoatmodjo, 2010). The consideration in this study is that each plot must have an area of 35 x 50 m^2 and not arid. Each area is made as many as 4 plots, so that the total of the four areas is 16 plots.

Sample Collection

Beetles (samples) were taken indirectly by using a *pitfall trap*. Planting *pitfall traps* in each plot will be carried out in the morning (07.00 AM). Each plot will be planted with five *pitfall traps each. Pitfall traps* that had been planted will be filled with a detergent solution with a volume of a quarter of the volume of the glass in each *trap* to trap and kill beetles Each plot were planted with five traps each. The planted traps were filled with a detergent solution with a volume of one-quarter the volume of glass in each trap to trap and kill beetles.

In addition to indirect retrieval, beetles were directly taken by hand (mechanical retrieval). Mechanical retrieval of beetles was carried out by searching in the litter and grass around the *pitfall trap* in each plot. The beetles obtained from mechanical retrieval were put into sample bottles containing 70% alcohol to preserve the beetles. *Pitfall traps* that have been planted in the morning are taken in the afternoon (15.00 WIB). The beetles trapped in the *pitfall trap* were taken and then rinsed with tap water. After rinsing, the beetles were put into a sample bottle filled with 70% alcohol. Sampling were repeated 3 times on each plot.

Data Analysis

Data was analysed using descriptive analysis. Descriptive analysis was conducted to describe each type of beetle, the abundance and dominance of the beetle along with the comparison of the abundance and dominance at each research location. The process of describing the H' value that has been obtained is also carried out.

In this research, we calculate INP (Important Index Value) using relative frequency and relative density (Sirait et al., 2018), and determine diversity index using Shannon-Wiener criteria (F.HOEK et al., 2013). For determine the dominance of the beetle, we used dominance index from Krebs (F.HOEK et al., 2013). Beetle identification process using website bugguide.net and Falahudin journal (2015).

RESULT AND DISCUSSION

Result from this research was determined by diversity index value (H'), INP (Important Value Index) which comes from the summation of the relative frequency and relative density of each type of beetle. This results show diversity, abundance, and dominance of Beetle species in housing and non-housing areas in UAD, Banguntapan.

Diversity of Beetle Species

The highest diversity of beetle species was the rice field area around campus with a diversity index value (H') 2,302; while the area that had the lowest diversity of beetle species was the campus with a diversity index (H') of 0.725.

Table 1. Values of INP and H' beetles in the UAD 4 campus area, rice fields, housing, and vacant land in Banguntapan sub-district, DIY

No.	Area	INP	H'
1.	Campus	200%	0,725
2.	Rice fields	199,997%	2,302
3.	Housing	200%	1,506
4.	Vacant land	199,999%	1,864

Based on Table 1 above, it can be seen that the comparison of INP and H' values between non-built land (paddy fields and vacant land) and built-up land (campus and housing) shows that non-built land has a higher diversity index than built-up land. The highest H' value of 2,302 in paddy fields means that the community is in moderate stability or moderate diversity (F.HOEK et al., 2013).The species improvement have positive correlated with the increased of the stability at the ecosystem level, but negatively correlated with the degree of species density due to a decrease in the population size of individual species (Lucini et al., 2020).

The diversity index value of 2.302 was obtained in the rice field area because the rice field area has environmental conditions that can support the survival of several types of beetles, such as microclimate conditions under the canopy and adequate food supplies (Sugiarto & Mersi, 2017).

Food supply for beetles in the field is related to crop rotation activities in the field to grow cultivated plants, the more diverse the types of weeds on cultivated plants, the more food for some species of beetles. The food supply for beetles is sufficient in the fields related to crop rotation activities in the fields to plant cultivated crops, the more diverse the types of weeds, because there are various weeds that are food for several species of beetles (Efendi et al., 2018). The crop rotation system by replacing different types of plants every few periods can increase the variety of plant species and maintain soil fertility. Crop rotation and proper cultivation of agricultural land can increase land productivity and maintain insect diversity. Crop rotation increases the abundance and effectiveness of insect predators and parasites. The crop rotation that creates diverse habitats provides these parasites and predators with alternative food sources, shelter and breeding grounds

(Ervianna et al., 2020). One of the ways to cultivate agricultural land is using organic materials and prioritizing the natural balance between living things and their environment. Organic farming systems are expected to maintain the habitat and diversity of living things in the agricultural area, including soil insects, considering the role of soil insects which is quite important in the soil material cycle. The existence of human activities in the rice fields is not as crowded as in the campus 4 area, only limited to planting, caring and harvesting activities, so that the lives of several species of beetles can be maintained.

The lowest diversity index value was found in the UAD 4 campus area of 0.725. The diversity index value of 0.725 means that the community is in an unstable condition or has low diversity (F.HOEK et al., 2013). This is because in the campus area 4 there are many human activities. According to research by Gámez-Virués *et. al*. (2015), the impact of intensive human activities can affect fluctuations in ecosystems, biodiversity and the response and resilience of a species, where this activity causes damage to the natural habitat of several beetle species. One form of disruption to massive human activities is physical development on a land (Badan Perencanaan Pembangunan Nasional, 2015).

Measuring ecosystem stability using the Shannon-Wiener diversity index (H'), if H' < 1 then the ecosystem is unstable; 1 < H' < 3 the ecosystem is in moderate condition.; and H'> 3 then the ecosystem is in a stable state because the diversity is high (F.HOEK et al., 2013).

Abundance of Beetle Species

The results of the research conducted in the UAD 4 campus area, rice fields, housing, and vacant land in Banguntapan District, DIY, found 6 families and 18 species of beetles.

Table 2. The abundance of beetles in the Ahmad Dahlan University Campus 4 area, rice fields, housing, and vacant land, Banguntapan district, DIY

No.	Beetle family	Species	C	RF	H	VL
1.	Cantharidae	*Rhagonycha fulva*	-	2	-	-
2.	Carabidae	*Bradycellus nigrinus*	-	-	1	-
3.	Chrysomelidae	*Altica cyanea*	-	1	1	-
		Cassida circumdata	-	1	-	-
		Dicladispa armigera	-	3	-	-
		Aspidomorpha miliaris	-	2	-	-
		Aspidomorpha sanctaecrusis	-	1	-	-
4.	Coccinellidae	*Coccinella transversalis*	4	3	1	7
		Curinus coeruleus	1	2	-	1
		Henosepilachna Vigintioctopunctata	-	5	-	1
5.	Scarabaeidae	*Anomala mongolica*	-	3	-	2
		Anomala sp.	-	-	-	2
		Cotinis nitida	-	2	-	-

		Onthophagus sp.	-	-	-	1
		Onthophagus taurus	-	-	1	1
		Popilia sp.	-	-	-	2
6.	Tenebrionidae	*Gonocephalum* sp.	197	20	11	19

Note : C = Campus
RF = Rice Field
H = Housing
VL = Vacant Land

Based on Table 3 above, it can be seen that the comparison between non-built land (paddy fields and vacant land) and built-up land (UAD campus 4 and housing) shows that the highest abundance of beetle species came from rice fields and vacant land, namely as many as 13 species in rice fields and There are 9 types on vacant land, while in the 4 UAD campus area, only 3 types are found and housing is 5 types. The highest abundance of beetle species was found in paddy fields because rice fields often rotate crops to be planted with cultivated plants, so that the types of weeds are also increasingly diverse. These various weeds are food for several species of beetles (Efendi et al., 2018). Beetles with the highest abundance was come from Family Tenebrionidae, because this beetles likes to eat leaf litter, that commonly found in each areas although with different levels. So, there is a lot of food source for this beetles.

The existence of crop rotation will certainly affect the type and abundance of weeds found in that location (Paiman, 2020). The types of beetles that stopped on cultivated plants were also more diverse than the types of beetles that stopped on non-cultivated plants. Cultivated crops, one of which is rice. (Fitriani, 2018) stated that, found many types of beetles from several families, such as Coccinellidae, Carabidae, and Staphylinidae. While in non-cultivated plants, for example weeds, the number of beetles found only came from the Coccinellidae Family, namely *Menochilus sexmaculatus* and *Coccinella* sp. (Rahmansah, S. & Puspitarini, RD., 2014).

Most of beetles that found in every areas was herbivore (such as family Tenebrionidae, Scarabaediae, Coccinellidae, and Chrysomelidae). On vacant land, fewer beetles are found because there is less food source for beetles there, causing by the types of plants that do not vary as a source of food for beetles. Weeds were found in the vacant land area, but the weeds found at the *sampling* did not vary in type. This causes the number of species and individuals of beetles found in the area is not as much as in the rice field area. This is supported by the statement of (Gouw & Gimenes, 2013), that on empty land is more dominated by the Order Hymenoptera, with the number of Coleoptera individuals found only 2 from the Chrysomelidae Family. Another study from (Maiti & Bidinger, 2012), also found that the number and types of beetles were less in vacant land compared to rice fields due to the lack of variety of weeds found in vacant land. The more diverse types of weeds found in an ecosystem, the more diverse types and more individuals of beetles will be found in that location(Efendi et al., 2018).

The lowest abundance of beetle species was found in the 4 UAD campus area. This is because there are very few types and numbers of plants, coupled with massive and dense human activities, making there are not many beetle species found in the UAD 4 campus area. Species richness and abundance of species found in a habitat depend on the level of disturbance in it. So that the small number of beetle species in the campus 4 area is due to the high level of disturbance on campus 4.

The impact of intensive human activities can affect fluctuations in ecosystems, biodiversity and the response and resilience of a species. One form of disruption to massive human activities is physical development which results in changes in land use change (Badan Perencanaan Pembangunan Nasional, 2015). Ecosystems that are still in the form of green land are changed to support people's lives and cause various environmental problems. Problems that arise as a result of this include changes in environmental quality, loss of natural habitat for flora and fauna, especially insects, and species extinction. Massive human activity in an ecosystem can certainly affect the abundance of beetles in it. This is in accordance with Riyanto (2017) statement that the composition and number of species of the Order Coleoptera in an ecosystem will vary due to different habitats and the influence of human activities. This statement is supported by the opinion of (Fitriani, 2018), that differences in habitat and the influence of human activities will affect the composition and number of species of the Order Coleoptera. Tenebrionidae was found abundantly in the entire area because this beetle has a role as a *scavenger* and likes to live on land where there is litter and rotting wood (Martin, 2012) .. This is supported by the conditions in each sampling area that has litter and piles of household organic waste that are favored by beetles from the Tenebrionidae family. The Tenebrionidae beetles in the larval and adult stages are rotten wood eaters. Another study conducted by Pamungkas & Ziqri, (2020) stated that beetle larvae prefer leaf litter, because leaf litter has a complex nutritional content for beetles. Intensive agriculture are the main drivers of the spread of beetle species and plays a crucial role in favoring non-native species richness and promoting the establishment of these species, e.g., by creating microclimatic conditions suitable for their settlement and spread (Della Rocca & Milanesi, 2022).

Carabidae was not abundant because members of the Carabidae family are insects that are active at night (nocturnal), while during the day these insects hide under leaves, under rocks, or under plant stems. Sampling activities carried out in the morning, afternoon, and evening to obtain diurnal beetles did not succeed in obtaining large numbers of the Carabidae Family. This is in line with the research conducted by (Ma'arif & Ni Made Suartini, 2014), which gets members from the Carabidae family only at night.

Dominance of Beetle Species

The results of the research that has been conducted in the UAD 4 campus area, rice fields, housing, and vacant land in Banguntapan sub-district, DIY, it was found that the area with the highest beetle dominance was the 4 UAD campus area with a dominance value of 0.585; while the area with the lowest beetle dominance was the rice field area of Banguntapan sub-district, DIY with a dominance value of 0.138.

Table 3. The dominance of beetles on campus 4 UAD, rice fields, housing, and vacant land in Banguntapan sub-district, DIY

No.	Sampling area	Dominance index
1.	Campus	0,585
2.	Rice fields	0,138
3.	Housing	0,252
4.	Vacant land	0,209

Based on Table 3 above, it can be seen that the comparison between non-built land (paddy fields and vacant land) and built-up land (4 UAD campus and housing), shows that the highest dominance index is in the UAD 4 campus area (built land). This is because in the UAD campus area, Banguntapan there are more *Gonocephalum sp.* from family Tenebrionidae than the number of other beetle species, with a total of 197 *Gonocephalum sp.* compared to 2 other types of beetles that were only found 4 and 1. According to(Munthe Yunita Veronika, 2012) the determination of the dominance index value (C) is by means of calculation method with Simpson dominance index formula provided if value dominance index $0 < C \leq 0.5$ then no genus dominates and if the index value dominance of $0.5 < C < 1$ then there is a dominating genus. The value of 0.585 means that the dominance in the area is moderate, which means that the dominance (mastery) in the area tends to be concentrated in one species (Nuraina, 2018). The existence of a moderate dominance value is caused because there are species that dominate other types (Mardi et al., 2016). While the dominance value in paddy fields (non-built land) is only 0.138, meaning that the dominance of beetles in that area is low. This means that almost no species dominates in the area (Odum, 1996).

In organic and non-organic agricultural land there was no beetle dominance. This is because agricultural land often rotates crops to be planted with cultivated plants, where the more varied the plants and the more diverse the types of weeds. These diverse varieties of plants and weeds are food for several species of beetles (Efendi, 2018) (Efendi et al., 2018). Organic farming land also uses fertilizers and organic materials in the planting process, this can prevent a decrease in diversity, so that there are many types of beetles and their dominance value is low (LATIFA et al., 2019).

CONCLUSION

The level of beetle diversity in the UAD 4 campus area was found to be low, while in other research areas the level of diversity was moderate. The beetle with the highest individual abundance in the UAD 4 campus area, rice fields, housing, and vacant land, Banguntapan District, DIY, *was Gonocephalum* sp., while the beetle with the lowest individual abundance in the 4 UAD campus area, rice fields, housing, and vacant land in Banguntapan District, DIY, namely *Bradycellus nigrinus*, *Cassida circumdata, Aspidomorpha sanctaecrusis, Verania lineata*, and *Onthophagus* sp. The beetle that dominates in the UAD 4 campus area, rice fields, housing, and vacant land is *Gonocephalum* sp. While the beetles that do not dominate in the UAD 4 campus area, rice

fields, housing, and vacant land are *Bradycellus nigrinus*. Campus has the lowest diversity and the highest dominance of beetles which could be a sign that human interference with land use change has massively changed the carrying capacity of the environment.

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