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Diversity and Functional Role of The Coleoptera Order in The Nglanggeran Ancient Volcano Area, Yogyakarta

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ABSTRACT

The aim of this research that was conducted in the Nglanggeran Ancient Volcano Area Yogyakarta was to determine the diversity and functional role of Coleoptera in the area. The research was conducted by survey, with observation method, in March-April 2021. Data were collected through purposive random sampling with Sorting, Yellow Pan Trap, and Hunting methods. The results of research at six stations indicated the presence of 30 individuals belonging to four families of Arthropoda order Coleoptera, namely *Lilioceris lilii* (Chrysomelida), *Charidotella sexpunctata* (Chrysomelidae), *Lytta stygica* (Meloidae), *Anisodactylus nigerrimus* (Carabaeidae), and *Harmonia axyridis* (Coccinellidae). Based on their functional roles, the Carabaeidae and Coccinellidae families that dominate this finding act as predators, while the Chrysomelidae and Meloidae families act as herbivores. The results of the analysis using PAST 4.07b software show that Coleoptera diversity in the area is included in the low diversity index category with a value of 0.773, a low species richness index with a value of 0.6213, and an evenly distributed abundance index with a value close to 1.

Keanekaragaman dan Peranan Fungsional Ordo Coleoptera di Kawasan Gunung Api Purba Nglanggeran, Yogyakarta

ABSTRAK: *Penelitian yang dilakukan di Kawasan Gunung Api Purba Nglanggeran Yogyakarta ini bertujuan untuk mengetahui keanekaragaman dan peran fungsional Coleoptera di kawasan tersebut. Penelitian dilakukan secara survei, dengan metode observasi pada bulan Maret-April 2021. Data dikumpulkan melalui purposive random sampling dengan kombinasi metode Sorting, Yellow Pan Trap, dan Hunting. Hasil penelitian di enam stasiun menunjukkan adanya 30 individu yang termasuk ke dalam empat famili Arthropoda ordo Coleoptera yaitu Lilioceris lilii (Chrysomelida), Charidotella sexpunctata (Chrysomelidae), Lytta stygica (Meloidae), Anisodactylus nigerrimus (Carabaeidae), dan Harmonia axyridis (Coccinellidae). Berdasar peran fungsionalnya, famili Carabaeidae dan Coccinellidae yang mendominasi temuan ini berperan sebagai predator, sedangkan famili Chrysomelidae dan Meloidae berperan sebagai herbivor. Hasil analisis menggunakan software PAST 4.07b menunjukkan bahwa keanekaragaman Coleoptera di kawasan tersebut termasuk ke dalam kategori indeks keanekaragaman rendah dengan nilai 0,773, indeks kekayaan jenis rendah dengan nilai 0,6213, dan indeks kelimpahan yang merata dengan nilai mendekati 1.*

INTRODUCTION

Nglanggeran Ancient Volcano is a mountain located in Nglanggeran Village, Patuk District, Gunungkidul Regency, Yogyakarta (Wiweka et al., 2021). This mountain is unique because it is a tertiary mountain that is 20-25 million years old and is part of the Sewu Mountains, which have been designated as Unesco Global Geoparks with a transitional climate from wet to dry (West Java-East Java) (Soviana et al., 2020). Mount Nglanggeran is used as an ecotourism site because of its abundant and diverse flora and fauna (Ismail et al., 2023). The uniqueness includes different edaphic, climatic, and biotic conditions compared to other volcanoes in Indonesia. Mount Nglanggeran Ecotourism Area has an area of 48 ha. The Nglanggeran Village area is 762.099 ha, primarily used for agricultural land, plantations, fields and yards (Suminar et al., 2023).

The Mount Nglanggeran area is also home to rare fauna and flora, such as the tremas plant (a medicinal plant that only lives in the Mount Nglanggeran ecotourism area) and long-tailed macaques (Vitrianto, 2023). The unique condition of an area is a factor that influences the presence of arthropod species in the area. If these factors are unsuitable for survival, the animal will disappear or not be found (Iqbal et al., 2021). The presence of arthropods in Mount Nglanggeran is also caused by its habitat and vegetation (Negara et al., 2021).

Arthropods can be found in various habitats, including on the surface or in the soil, as well as in the Mount Nglanggeran Tourism Area (Harahap et al., 2020). Coleoptera is one of the most significant insect orders besides Hymenoptera, Diptera and Lepidoptera (Susanto & Arianti, 2021). Coleoptera can be found in several places, such as various plant species, under rocks, bark, soil, and fungi (Freeman et al., 2020). Coleoptera larvae are generally found in soil, plant parts, seeds or other materials. Coleoptera interact with ecosystems in several ways (Kozlov et al., 2020). Coleoptera often eats some parts of plants, fungi, and some even eat other animals (Potapov et al., 2022).

The Coleoptera order has abundant diversity and plays a role in ecosystem function. The functional role of Coleoptera is grouped into four groups, namely predators, herbivores, mycophagous (fungi eaters), and detritivorous (organic matter eaters and scavengers) (Parisi et al., 2020). The role of Coleoptera is related to the diversity of some of these genera (Bernardes et al., 2020). The behaviour patterns of members of the Coleoptera order mainly occur in or above the ground and are related to their role in the ecosystem (Kirmse & Chaboo, 2020).

The research conducted at Mount Nglanggeran aims to determine the diversity and functional potential of Coleoptera in the habitat because existing research at Mount Nglanggeran to date is still limited to the fields of geology, vegetation analysis, inventory of butterfly diversity and introduced plants that make up the vegetation of Mount Nglanggeran.

METHOD

Time and Location

This research was implemented at Nglanggeran Ancient Volcano. The observation location was determined by purposive random sampling, namely through the climbing tourist route and the climbing descent route from Mount Nglanggeran.

The route was divided into six observation stations which were then observed for seven days, from 09.00-13.00 March to April 2021. The route was divided into six observation stations which were then observed for seven days, from 09.00-13.00 March to April 2021.

The station there are (1) Song Gudel, (2) Viewpoint 1, (3) Viewpoint 3, (4) Bagong Mountain, (5) Viewpoint 4, and (6) Viewpoint 5.

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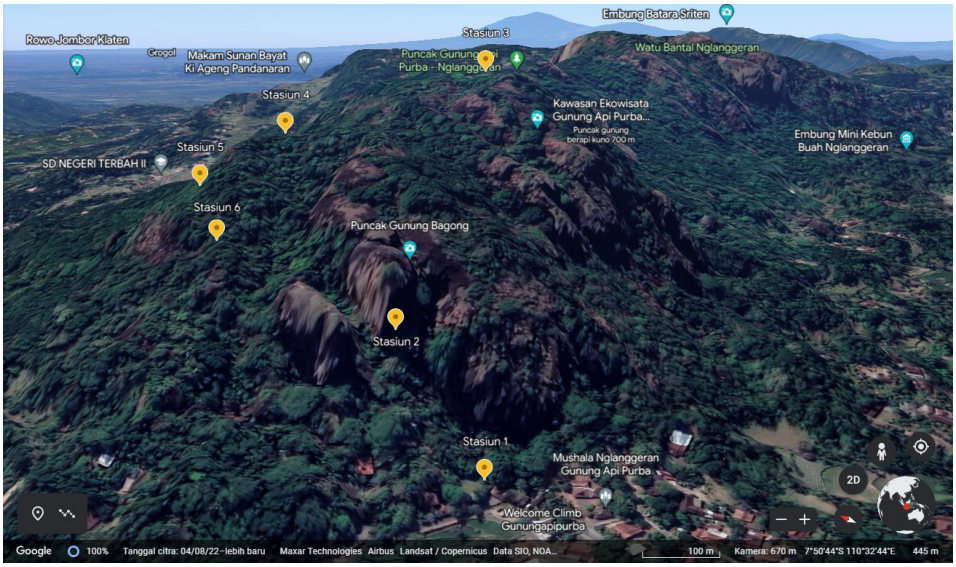

Figure 1. Field site

Tools and Materials

Tools and materials used in this study include stationery, insect net, yellow pan trap, sample bottle, killing bottle, digital camera, soil tester, air thermometer, soil thermometer, hygrometer, lux meter, anemometer, shovel, bucket, tweezers, microscope, latex gloves, identification book, chloroform, 70% alcohol.

Methods

This survey research directly observes biotic and abiotic components in the Mount Nglanggeran area, Yogyakarta. This study focused on the arthropods of the soil macrofauna group, namely the Coleoptera order. Data were collected using a combination of litter sorting, yellow pan trapping, and hunting methods.

Secondary data were used in this observation in the form of climatic and edaphic data aimed at knowing the characteristics of the habitat of members of the Coleoptera order. The data include soil temperature, air temperature, soil pH, soil moisture, wind speed, light intensity, and altitude. The data analysis technique used is the PAST (Paleontological Statistics) version 4.07 application which includes the Shannon-wiener index, margaleff richness index, and evenness index. Other data analysis was carried out using descriptive analysis; then, the index was described and associated with the habitat of Coleoptera species based on a comparison with the Introduction to the Identification of Beetles (Coleoptera) and https://bugguide.net.

RESULTS AND DISCUSSION

Mount Nglanggeran has a height of between 200-700 meters above sea level with central coordinates -7.841986 and 110.5415759 (Aprilianti et al., 2021). Data collection was carried out from March-April 2021, the rainy season in the Yogyakarta Special Region, so this impacts data diversity. This is indicated by several methods that cannot adapt to rainy season conditions accompanied by strong winds.

This research determines the observation points into six stations with the division, namely 1) Song Gudel with coordinates S 07º 50.572', E 110º 32.286' (1392 Ft), 2) Viewpoint 1 with coordinates S 07º 50.521', E 110º 32.321' (1495 Ft), 3) Viewpoint 3 with coordinates S 07º 50.452', E 110º 32.589' (2047 Ft), 4) Bagong Mountain with coordinates S 07º 50.402', E 110º 32.429' (1850 Ft), 5) Viewpoint 4 with coordinates S 07º 50.391', E 110º 32.371' (1774 Ft), and 6) Viewpoint 5 with coordinates S 07º 50.429', E 110º 32.333' (1752 Ft).

The observations showed that the abundance of Coleoptera in each vegetation stratum is more significant in the dry season than in the rainy season. Meanwhile, the richness and abundance of Coleoptera species are more significant in the rainy than the dry season (Michienzi et al., 2021). The higher the level of shade, the lower the air temperature, soil temperature, and light intensity, but the higher the air humidity (Pratama et al., 2023). This causes Coleoptera to experience aestivation, especially in areas with different wet and dry seasons; humidity can be an essential stimulus for development and developmental activities (Ariza et al., 2021). Therefore, the increase in Coleoptera abundance is also caused by lower air temperature and light intensity (Kirichenko-Babko et al., 2020). Daphic climate data obtained during the observations are provided in Table 1.

Table 1. Average Edaphic Climatic Conditions per Station at Mount Nglanggeran

Station	Altitude (ft)	Temperature (°C)	Soil Temperature (°C)	Soil pH	Soil Humidity	Wind Speed (Knot)
1	1392	28	26	6.8	4.5	0.9
2	1495	25	26	6.6	3.25	0.8
3	2047	27	27	6.5	3.25	1.7
4	1850	25	25	6.4	3.2	1.7
5	1774	27	28	6.8	2.5	1.7
6	1752	28	28	6.5	3.2	1.6

Each different altitude zonation at various stations does not affect the richness of the number of species because most species are limited to environments with specific characteristics (Muthmainnah et al., 2023). Thus, the research showed that Coleoptera diversity at Mount Nglanggeran was unaffected (Table 2). However, lower altitudes show abundant diversity. This is because these altitudes have different gradations of vegetation, proving that the abundance of Coleoptera species is influenced by specific characteristics at each observation station outside the researcher's observations.

Table 2. Vegetation Description of each Station on Mount Nglanggeran

Station	Description
1 (1392 ft)	The cave has an open 'entrance' and is composed of large rocks, a dry climate, and dry and sandy soil; plant vegetation is found around the cave, such as ferns and mosses found at the entrance to the cave while above the cave is overgrown by ferns (20%), herbs (20%) and mosses (60%). Around the cave, there are also approximately 26 stands and shrubs.
2 (1495 ft)	Having predominantly closed vegetation, this station is surrounded by rocky cliffs between station roads one and three. There are approximately 11 stands, with lush canopy cover (70%), herbs (55%), shrubs (35%), mosses (60%), and ferns (25%), with a wet climate and soil.
3 (2047 ft)	In areas with dominant closed vegetation with a wet and humid soil climate, there are 59 stands, canopy cover reaches 70%, herbaceous plants (60%), and shrubs (15%).
4 (1850 ft)	The vegetation in this area is dominantly closed, with a humid soil climate, and covered by shrubs (70%), herbs (20%), mosses (5%), and ferns (5%). This area has a very lush canopy cover with approximately 86 stands.
5 (1774 ft)	This area has balanced open (45%) and closed (55%) vegetation. A canopy with approximately 27 stands covers this area, the soil climate is humid and closed, and some areas are covered by herbs (40%), rocks (10%), and shrubs (35%).
6 (1752 ft)	This area has balanced open (45%) and closed (55%) vegetation, moist soil climate with part of the area covered by rocks (70%), herbs (10%), shrubs (20%), and canopy cover dominated by stands with approximately 28 stands and ten clumps of bamboo around the area.

Arthropod observations showed that the most common family found during this study was the Coccinelidae family, with 21 individuals and dominance found in bushes, twigs, and leaves (Table 3). Coleoptera found in this study used several methods to obtain arthropods (order Coleoptera) of various types, such as terrestrial, arboreal, and aerial macro arthropods.

Table 3. Number of Individuals Obtained at the station of observation

Station	Technique	Family	Substrate	Number
1	Hunting	Coccinellidae	Shrubs, twigs	4
2	Hunting	Chrysomelidae	Shrubs	1
		Coccinellidae	Shrubs	5
3	Hunting	Chrysomelidae	Shrubs	2
4	Hunting	Meloidae	Shrubs	3
		Chrysomelidae	Leaves	2
5	Hunting	Coccinellidae	Shrubs, twigs	7
	Shorting	Carabaeidae	Dry litter	1
6	Hunting	Coccinelidae	Bamboo twigs	5
Grand Total				**30**

From the results of the above data, the Shannon-Wiener index (H'), Margalef index, and Eveness index were obtained using the PAST (Paleontological Statistics) application with the latest version, 4.07. The three indices can already represent diversity data (Nahiduzzaman et al., 2023).

Shannon-Wiener index (H') is at 0-0.773; it falls into the category of low diversity level. The population's diversity can be low if H'< 1.5. The Margaleff index is 0-0.6213 which means low species richness. Margaleff's index shows a ratio of Dmg < 3.5; then, the species richness is low with the number of one species to the number of all species (Khatimah et al., 2022). While the Evenness Index is at 0.7758-1.083, which indicates an even abundance. The evenness value has a range between 0-1, if the index value obtained is close to one, it means that the distribution is more evenly distributed (Yang et al., 2020).

The vegetation at Mount Nglanggeran is dominated by closed vegetation with canopy cover dominating the entire area. The Coleoptera order was not found in all stations with details, namely station 1 (1 family), station 2 (2 families), station 3 (1 family), station 4 (2 families), station 5 (2 families), and station 6 (1 family). Coleoptera communities develop dominantly in closed vegetation with a humid soil climate and area cover dominated by various plants. In addition, the dominance of Coleoptera richness was found at the initial altitude of 1300 - 1700 meters above sea level. This shows a relationship between the altitude of a location and the richness of a species and climatic variations at each observation site will have a more significant influence on the diversity of an Arthropod community (Matzka et al., 2021).

Coleoptera has a variety of vegetation types caused by biotic and abiotic factors (Wilkaniec et al., 2021). This area has typical habitat conditions such as being overgrown by termas plants. Air temperature is a controlling factor related to the distribution of vegetation in an area (Jiao et al., 2021).

The diversity of plant communities in an area will affect the distribution and interaction of each animal species—moreover, most of the Coleoptera order food from various parts of the plant. Food availability in a location is one factor that provides a natural habitat for insects in the ecosystem (Jiang et al., 2020).

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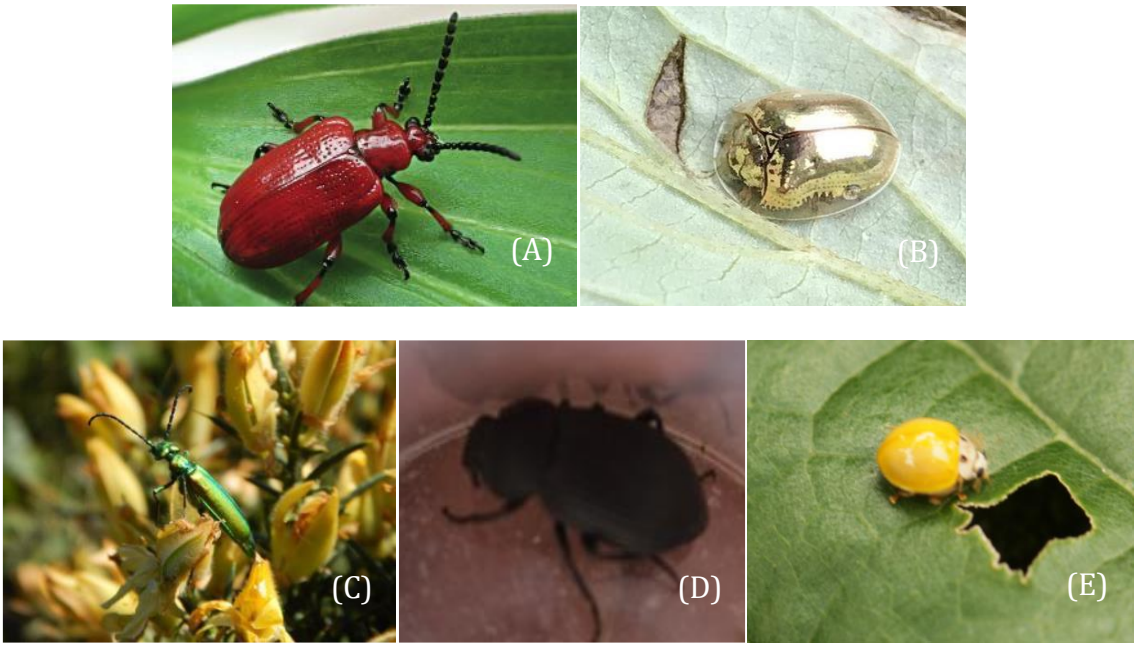

Figure 2. A) *Lilioceris lilii*, B) *Charidotella sexpunctata*, C) *Lytta stygica*, D) *Anisodactylus nigerrimus*, E) *Harmonia axyridis*

Lilioceris lilii (Figure 2A) is a long-horned beetle belonging to Chrysomelidae. This species has a body length of 4-10mm. The body is long and narrow, with a prominent shoulder between the elytra and pronotum. Adults take refuge in the soil during winter, reappearing between April and May through September. Adults and larvae cause damage to plants, as they feed on the leaves, buds, stems, and flowers of some plants such as lotus, onion, and garlic. These beetles inhabit forest edges, fields, and gardens (Magura & Lövei, 2021).

Charidotella sexpunctata (Figure 2B) is a leaf beetle in the Chrysomelidae family native to the Americas. This genus has a round body shape with a body size of 5-7 mm, a transparent cuticle, and a complex but flexible outer cover that can protect the inside of the body. This beetle has a metallic or golden color. It has short antennae where the tips of the antennae are blackish. When disturbed, golden ladybugs can change color from shiny gold to reddish brown. Both juvenile ladybugs and larvae consume the foliage of flora from the Convolvulaceae family. This genus commonly lives in rice fields, gardens, and forest margins (Kurlansky, 2019).

Lytta stygica (Figure 2C) is the most prominent member of the Meloidae family's genus, with wings covering most of the dorsum. It has a hard exoskeleton and elytra and spiracles along the body's sides. The mouthparts are chewers, and the mandibles are well-developed. In the Eastern United States, Lytaa is reported as a pest of peaches, plums, apples, and pears. This genus migrates to maximize the ability to survive in various habitats or to find mating partners. The genus prefers moist areas, sometimes even found in dark caves. It is often found in flowers and leaves because this insect can migrate using the Phoresy technique (attaching to other insects to move to distant places) (Qi et al., 2019);(Merkel et al., 2021).

Anisodactylus nigerrimus (Figure 2D) is a member of the Carabaeidae family with many variations in its habits. Some members of the Carabaeidae family are fecal feeders or eat decaying plant minerals or carrion. Some live in the nests of ants or termites, and some are severe pests of diverse agricultural products (Grodsky et al., 2020). However, species of the Carabaeidae family have a

significant role in the ecosystem as predators of small arthropods.

Harmonia axyridis (Figure 2E), the Asian Koksi beetle, is 7 mm long and about 5 mm wide. The body is oval-shaped and convex, generally yellow to orange in color in unspotted beetles. Coccinellidae has a reasonably high diversity; there are an estimated 5000 species worldwide, while in Indonesia, it is estimated that more than 300 species are widely distributed (Florencio et al., 2019). These beetles can be found in almost all vegetation, especially in deciduous trees, flowering plants, and plant species found in open areas. This member of the Coccinellidae family is also a predator capable of enhancing biological control of soft-bodied pests in various crops, gardens, and landscapes. When disturbed, adults may secrete an odorous orange liquid for self-defense (Hatt et al., 2019).

In the four families found, based on their functional roles, they can be grouped into two. Most of the specimens found namely the Carabaeidae and Coccinellidae families, have a role as predators of small arthropods. In contrast, the Chrysomelidae and Meloidae families act as herbivores on various plants.

Thus, the distribution of Coleoptera in Mount Nglanggeran can be interpreted that the population dynamics of some Arthropod diversity are not explicitly affected by environmental or vegetation characteristics but to some extent by ecological drift and dispersal (Pedley & Dolman, 2020). Biological interactions between Arthropod communities along sites with similar flora, fauna, climate, soil, and water availability play a significant role in determining Arthropod diversity in vegetation (Pequeno et al., 2021); (Marta et al., 2021). Ultimately, the diversity and distribution of Coleoptera at Mount Nglanggeran are limited by the variables observed in this study and specific characteristics.

CONCLUSIONS AND SUGGESTIONS

In this study, four families of Arthropods of the Order Coleoptera were found, namely *Lilioceris lilii* (Chrysomelida), *Charidotella sexpunctata* (Chrysomelidae), *Lytta stygica* (Meloidae), *Anisodactylus nigerrimus* (Carabaeidae), and *Harmonia axyridis* (Coccinellidae). The Shannon-Wienner index (H') is 0-0.773 (low), the Margaleff index is 0-0.6213 (low), and the Evenness Index is 0.7758-1.083 (even). The Carabaeidae and Coccinellidae families are predators, while the Chrysomelidae and Meloidae are herbivores on various plants.

Research must be carried out repeatedly and over a more extended period to obtain more comprehensive data.

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