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Macroarthropod Diversity, Distribution, and Community Structure in Cikarae Cave of the Klapanunggal Karst, West Java

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ABSTRACT

Arthropods are the most dominant fauna in cave realms. Ecological studies of cave-dwelling arthropods are essential for cave ecosystem conservation. This study was conducted to determine the ecological aspects of macroarthropods in Cikarae Cave, West Java, focusing on their diversity, distribution, and community structure. The cave passage was divided into three zones based on environmental disparities. Data collection was carried out through direct search and counting methods. Data were analyzed using non-metric multidimensional scaling (NMDS) and several ecological indices (diversity, evenness, and dominance). Nineteen macroarthropod morphospecies were recorded and distributed among 5 classes, 11 orders, and 18 families. Most of these morphospecies were troglophiles. A new troglobitic species (Isopoda: Philosciidae) with a high degree of troglomorphy and exclusive microhabitat was registered. Most morphospecies were collected in Zone 1 (17), followed by Zone 3 (9) and Zone 2 (8). Collected macroarthropods preferred cave walls over floors and ceilings. Overall, Cikarae showed a low diversity index (0.782) and evenness (0.265), while dominance was relatively high (0.692). *Trachyjulus tjampeanus, Rhaphidophora* sp., and *Theridiosomatidae* sp. were the most dominant taxa.

1. Introduction

Arthropods are the most successful faunal group on Earth. They are also the most dominant taxon in terms of diversity and abundance. The phylum has a remarkable adaptation ability, allowing its presence in almost all types of ecosystems. More than 1.3 million species of arthropods have been described, most of which belong to insects and arachnids (Chakravarthy *et al.* 2016). Nevertheless, this number is considered far less than their actual diversity, as efforts to sample and describe global arthropod diversity have been limited (Mora *et al.* 2011). Ecologically, arthropods play essential roles as they are the main component of food webs and occupy different trophic levels (Wong *et al.* 2019). Thus, their existence is crucial for ecological sustainability (Lingbeek *et al.* 2017).

The cave realm is a challenging habitat for many animals due to its peculiar environmental conditions (Kurniawan *et al.* 2022a). The absence of sunlight brings major obstacles to species that rely on visual organs. It also prevents the presence of photosynthetic organisms, resulting in limited food quality and quantity (Lunghi and Manenti 2020). Almost all nutrients in caves are allochthonous, except for chemoautotrophic production and plant roots that contribute to small fragments of organic matter in caves (Prous *et al.* 2015). In addition, cave dwellers must cope with an extreme (although stable) microclimate, low oxygen concentration, and relatively high humidity close to saturation (Howarth and Moldovan 2018a).

Despite these extreme environmental conditions, caves are essential habitats for many macroarthropods (Romero 2009; Mazebedi and

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Hesselberg 2020; Silva *et al.* 2020). Macroarthropods are essential components of cave ecosystems because of their diversity, abundance, and ecological functions. They are the leading actor in most cave nutrient cycles (Parimuchová *et al.* 2021). Cave-dwelling macroarthropods exhibit varying degrees of troglomorphy, a general term for adaptive features associated with cave dwellers. These adaptations involve morphological, physiological, behavioral, and other specialized features (Howarth and Moldovan 2018a).

Based on the degree of adaptation and behavior, they can be classified as troglobites, troglophiles, or trogloxenes (Mammola 2019; Kurniawan *et al.* 2022b). Troglobites (troglobionts) are obligate or permanent residents of cave habitats which show a high degree of troglomorphy, such as depigmentation, eye reduction, and structure elongation. Troglophiles comprise species with some degree of troglomorphy and have both cave and surface populations. Meanwhile, trogloxenes are facultative cave residents without troglomorphy that associate with surface habitats for some of their life cycles (Culver and Pipan 2009; Romero 2009; Trajano and de Carvalho 2017).

Cikarae is a cave in Klapanunggal, a karst formation from the Early Miocene (23.03–15.97 Ma). The karst is threatened by a massive limestone quarry operated by two large mining companies. Extensive limestone mining was started in 1976. Cikarae is a habitat for *Stenasellus javanicus* Magniez and Rahmadi 2006, a stigobiotic isopod endemic to Klapanunggal Karst first discovered in the cave (Magniez and Rahmadi 2006). The cave is frequently explored but lacks scientific research. Until recently, the description of *S. javanicus* was the only published scientific article revealing the biospeleological condition of the cave. However, according to initial observations from this study, the cave is rich in other macroarthropods. The general aim of the present study was to determine the ecological aspects of cave-dwelling macroarthropods in Cikarae, focusing on their diversity, distribution, and community structure. The results of this study are expected to give a scientific basis for developing Cikarae as a biospeleological field laboratory to prevent further destruction of the cave.

2. Materials and Methods

2.1. Study Site

This study was conducted from July to August 2022 in Cikarae Cave in Klapanunggal Karst, Bogor Regency, West Java. The cave has two entrances and one aven, a hole or channel in the cave ceiling that connects the cave passage to the surface environment. The main entrance occurs at geographical coordinates: -6.51511, 106.92086. This location is near a road and a public elementary school (about 100–200 m). The cave is 330 m long and is divided into 3 main sections (Figure 1). All cave passages are horizontal in projection and relatively easy to explore. Cikarae Cave has been explored frequently by local cavers and speleological activists. In addition, it is owned privately by a local who does not live far from the cave. The owner constructed a gate over the main entrance.

Cikarae is one of the most famous caves in Klapanunggal. It is well known as the habitat of *Stenasellus javanicus*, a stygobiotic isopod first discovered in the cave. The cave has both aquatic and terrestrial habitats. The cave passages bear various microhabitats in which macroarthropods thrive. Several ceiling parts were used as roosting sites for insectivorous bats, particularly from the genera *Rhinolophus* Lacepede, 1799, *Miniopterus* Bonaparte, 1837, *Hipposideros* Gray, 1831, and *Myotis* Kaup, 1829. The bats produce guano, the cave's primary source of organic matter. Fragments of other organic debris, mainly plant litter, were also found sparingly at several sites.

2.2. Macroarthropod Collection and Identification

The cave was explored thoroughly to collect data on species diversity and abundance. The cave passage was divided into three sampling sites: Zone 1, Zone 2, and Zone 3 (Figure 1). The division was established based on differences in

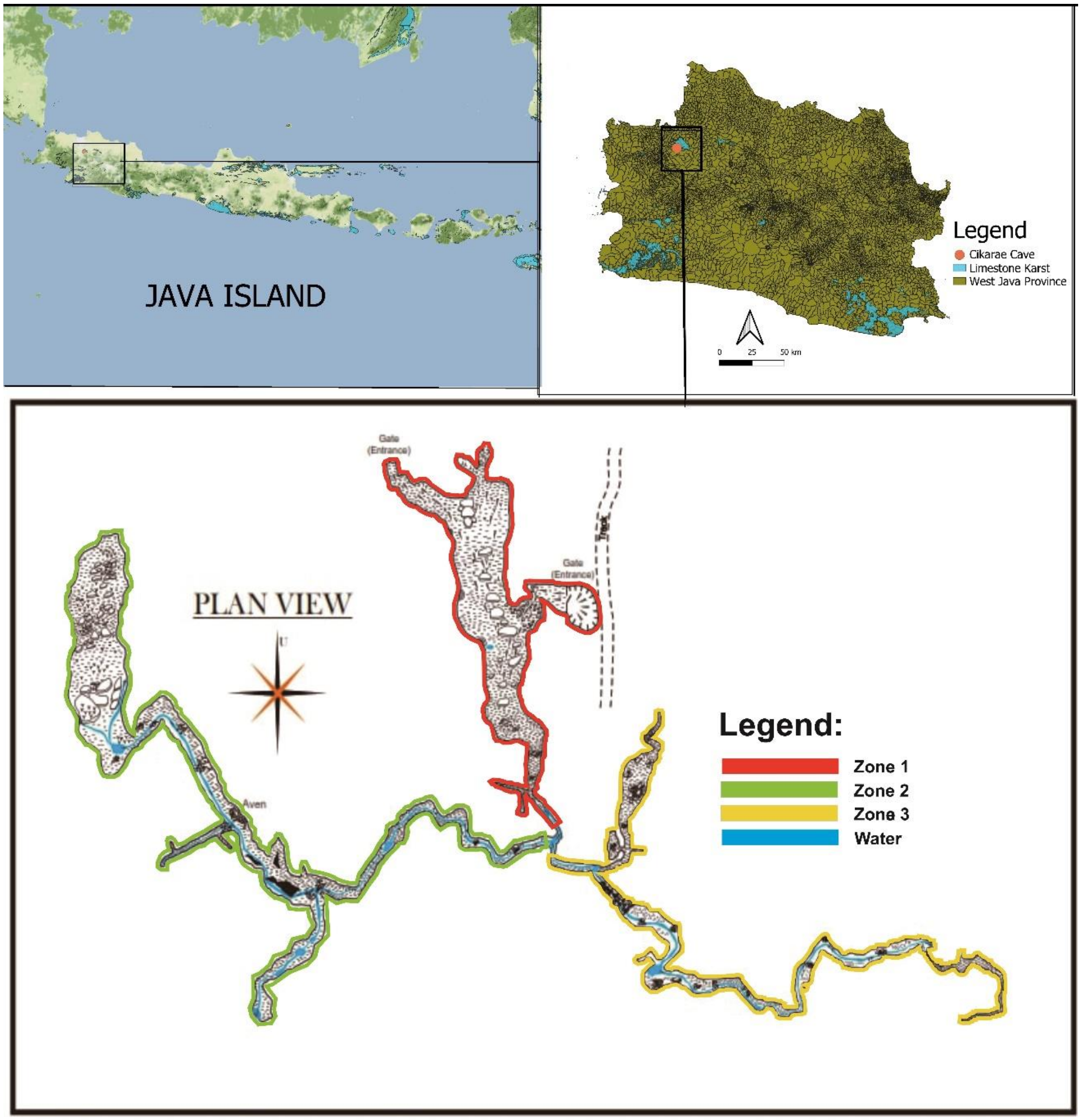

Figure 1. Geographical position and map of Cikarae Cave, Klapanunggal Karst, Bogor Regency, West Java, with zone categorization for the present study. The cave map was modified from the original version drawn by MAPENTA UNISBA

visual characteristics (Table 1). In addition, the three zones were relatively different in some basic environmental parameters, particularly light intensity, air temperature, and soil pH (Table 1).

Macroarthropods were captured at each sampling site via direct search and hand collecting with the help of tweezers and brushes (Wynne *et al.* 2019; Simoes *et al.* 2022). The number of individuals was estimated through direct counting. The observation was focused on all typical terrestrial cave microhabitats, such as guano piles, plant litter, rock crevices, humid soil, under stones, etc. Two observers with experience in caving and collecting cave-dwelling arthropods carried out the collection. Each sampling site was observed for 1 hour, with 2 repetitions conducted in different sampling efforts (always by the same observers). Samplings were started from Zone 1, followed by Zones 2 and 3, respectively.

A maximum of 3 individuals from each species were preserved in 96% alcohol for identification. Preserved specimens were sorted and identified under stereo microscopes (Nikon SMZ18). Identification was conducted using the morphospecies concept up to the lowest possible taxonomic level (Oliver and Beattie 1996). In addition, collected specimens were classified into their ecological roles (decomposer

Table 1. Environmental characteristics of each sampling site at Cikarae Cave, Klapanunggal Karst, Bogor Regency, West Java.

Sampling site	Visual characteristics	Light intensity (lux)	Air temperature (°C)	Relative humidity (%)	Soil moisture (%)	Soil pH
Zone 1	Connecting to both entrances, a large chamber without an underground river, several ponds generated by percolating water, rich in guano, and large quantities of soil on the ground	0.02	24.1	89	100	6.1
Zone 2	Includes underground river and percolating water, large chamber and long narrow passage, a small aven, chamber at the end of long narrow passage without water, rich in guano, medium quantities of soil on the ground	0	25.7	96	100	5.0
Zone 2	Long narrow passage with an underground river and percolating water, a small dry chamber, guano less abundant than in Zones 1 and 2, without entrance and aven, lack of soil substrate	0	26.35	99	100	5.6

or predator) and cave adaptation categories (troglophile, trogloxene, and troglobite). The classification into ecological roles relied on the role occupied by most species in the taxonomic group, with supporting traits including types of mouthparts and the modification of pedipalps in predatory species. The cave adaptation category was determined based on the degree of troglomorphism, mainly indicated by depigmentation, eye reduction, elongated appendages, antennae, and other sensory organs (Howarth and Moldovan 2018a; Manenti and Piazza 2021). Expert judgment was used whenever required. The identification and classification took place in the zoology laboratory of UIN Sunan Gunung Djati Bandung and Museum Zoologicum Bogoriense, National Research and Innovation Agency (BRIN).

2.3. Data Analysis

Non-metric multidimensional scaling (NMDS) was performed to analyze the distribution of macroarthropods in cave zones. Several ecological indices, including diversity (Shannon-Wiener), evenness (Pileou), and dominance (Simpson), were examined to show macro arthropod community structure at each sampling site. All analyses were performed using Rstudio under the Vegan package (Oksanen *et al.* 2020). Results are presented as tables, graphics, figures, and plots for better visualization and interpretation.

3. Results

3.1. Macroarthropod Composition and Abundance

A total of 2,052 individual macroarthropods distributed into 5 classes, 11 orders, 18 families, and 19 morphospecies were recorded, and their taxonomic classification, ecological role, microhabitat location, and abundance were documented (Table 2). These registered groups are common in many Indonesian caves.

Arachnida (7 spp.) and Diplopoda (6 spp.) accounted for more than 68% of the total richness and were the most morphospecies-rich classes. Other classes contributed relatively lower richness, including Insecta (3 spp.), Malacostraca (2 spp.), and Chilopoda (1 sp.). In terms of abundance, Diplopoda contributed the most, with 1,724 individuals or more than 84% total abundance. Insecta and Arachnida were the second and third most abundant groups, with 172 and 130 individuals, respectively. The least abundant classes were Malacostraca and Chilopoda, which included only 23 and 3 individuals, respectively.

Table 2. Morphospecies classification, ecological role, microhabitat location, and abundance of macroarthropods at Cikarae Cave, Klapanunggal Karst, Bogor Regency, West Java

Class	Order	Family	Morphospecies	Abundance	Ecological role	Cave adaptation	Microhabitat location
Arachnida	Acari	Trombidiformes	*Trombidiformes* sp.	1	D	Tp	Wall
	Amblypygi	Charinidae	*Sarax javensis*	1	P	Tp	Wall
		Charontidae	*Catagaeus dammermani*	20	P	Tp	Floor, wall, ceiling
	Araneae	Pholcidae	*Pholcus* sp.	2	P	Tp	Crevices in wall
		Salticidae	*Salticidae* sp.	1	P	Tp	Wall
		Theridiosomatidae	*Theridiosomatidae* sp.	100	P	Tp	Crevices in wall
	Uropygi	Thelyphonidae	*Thelyphonus* sp.	5	P	Tp	Wall and floor
Chilopoda	Scutigeromorpha	Scutigeridae	*Scutigera* sp.	3	P	Tp	Floor, wall, ceiling
Diplopoda	Polydesmida	Haplodesmidae	*Cylindrodesmus hirsutus*	20	D	Tp	Wall
		Opisotretidae	*Opisotretidae* sp.	1	D	Tp	Wall
		Pyrgodesmidae	*Ampelodesmus* sp.	1	D	Tp	Wall
			Cryptocorypha sp.	1	D	Tp	Wall
	Spirostreptida	Cambalopsidae	*Trachyjulus tjampeanus*	1,700	D	Tp	Guano piles on the floor and wall
		Harpagophoridae	*Thyropygus* sp.	1	D	Tp	Floor
Insecta	Coleoptera	Carabidae	*Carabidae* sp.	6	P	Tp	Cave wall
	Diptera	Tipulidae	*Tipulidae* sp.	61	D	Tp	Wall
	Orthoptera	Rhaphidophoridae	*Rhaphidophora* sp.	105	D	Tp	Guano piles, floor, and wall
Malacostraca	Isopoda	Armadillidae	*Armadillidae* sp.	19	D	Tp	Floor and wall
		Philosciidae	*Philosciidae* sp.	4	D	Tb	Guano piles on the floor

Ecological role: D = Decomposer, P = Predator; cave adaptation: Tp = Troglophile, Tx = Trogloxene, Tb = Troglobite

Macroarthropods found in this study comprised two main functional groups: decomposers and predators. Most morphospecies belonged to decomposers (11 spp.), whereas predators were slightly less diverse (8 spp; Figure 2A). Moreover, decomposers outperformed predators in abundance. This group accounted for over 93% of the total abundance, with 1,913 individuals (Figure 2B). One decomposer, *Trachyjulus tjampeanus* Attems, 1903 (Figure 3A), contributed 1,700 individuals or more than 88% of total decomposer abundance. *Rhaphidophora* sp. (Figure 3B) also had a noticeable abundance (105 individuals). Of the predatory groups, *Theridiosomatidae* sp. (Figure 3C) dominated with 100 individuals (71% of total predator abundance).

According to their microhabitats (Figure 2C), the bulk of species richness occurred on the cave wall (17 spp.), followed by the floor (7 spp.). Only two morphospecies were observed on the ceiling: *Catagaeus dammermani* Roewer, 1928, and *Scutigera* sp. However, these two morphospecies were also found on cave walls and floors. Several morphospecies were actively mobile and embraced a wide range of microhabitats. Besides the two morphospecies mentioned above, *Thelyphonus* sp., *T. tjampeanus*, *Rhaphidophora* sp., and *Armadillidae* sp. were also observed in more than one microhabitat type.

The vast majority of morphospecies (95%) collected in this study were classified as troglophiles. They displayed a low degree of troglomorphy or did not exhibit any of the typical traits at all. *Catagaeus dammermani* and *Rhaphidophora* sp. were reported leaving the cave at night, but it was only the case for a small part of the populations that inhabited the entrance area. They also indeed exhibited some degree of troglomorphy. Therefore, they were still categorized as troglophiles instead of trogloxenes. Meanwhile, one morphospecies was suspected to be a potential troglobite: *Philosciidae* sp. This terrestrial isopod exhibited several troglomorphic traits, mainly depigmentation and eye reduction. Compared to surface relatives from the same family, eye size was significantly smaller and appeared like membrane-coated spots (Figure 4).

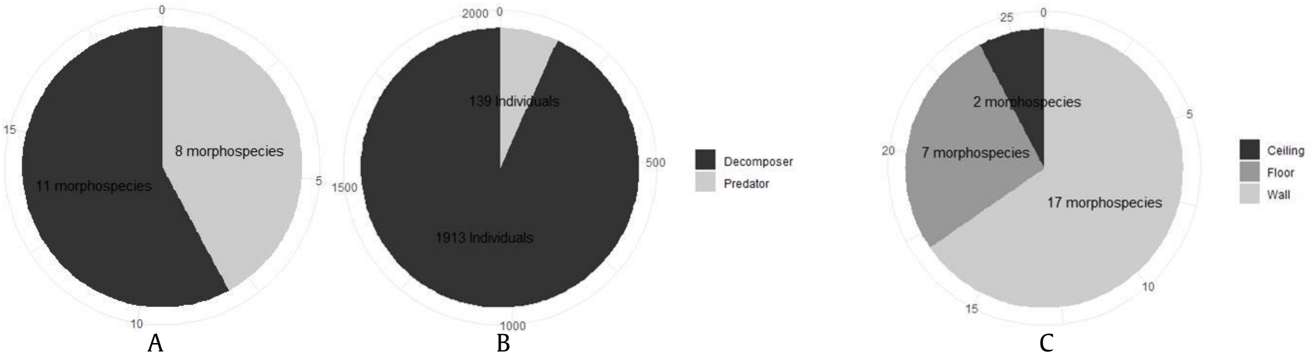

Figure 2. The proportion of macroarthropods based on ecological roles (A, B) and microhabitat (C) in Cikarae Cave, Klapanunggal Karst, Bogor Regency, West Java. Comparison of ecological roles (decomposer, predator) based on (A) species richness and (B) abundance. (C) Comparison of microhabitat (ceiling, floor, wall) based on species richness

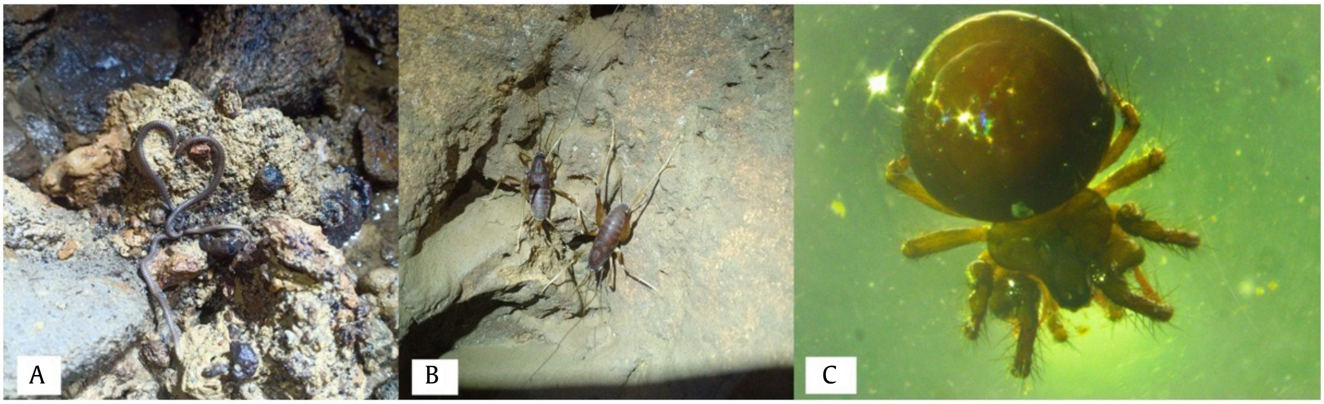

Figure 3. The most abundant morphospecies in Cikarae Cave, Klapanunggal Karst, Bogor Regency, West Java. (A) *Trachyjulus tjampeanus* Attems, 1903, (B) *Rhaphidophora* sp., (C) *Theridiosomatidae* sp.

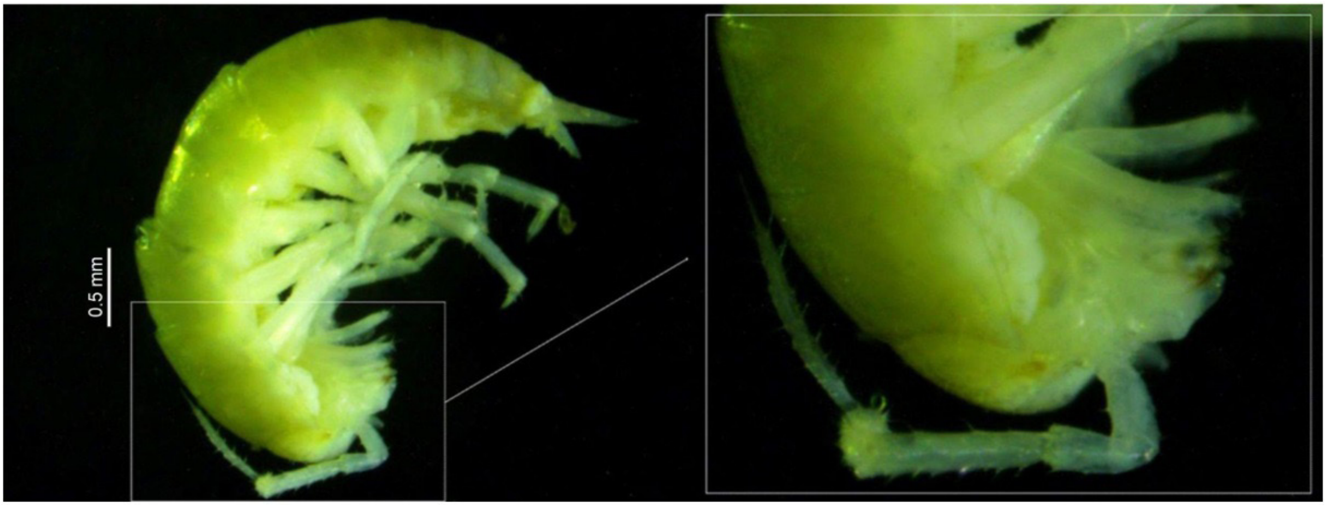

Figure 4. Potential obligate isopod cave species from the family Philosciidae in Cikarae Cave, Klapanunggal Karst, Bogor Regency, West Java

3.2. Distribution of Macroarthropods

Macroathropods were distributed unevenly among sampling sites (Figure 5). Zone 1 was the wealthiest site with 17 spp. The other sites had significantly lower richness, about half that of Zone 1. Zone 3 was inhabited by 9 spp., while Zone 2 had 8 spp. Zone 1 also had the greatest abundance of macroarthropods, with ca. 1,182 individuals recorded. This abundance was much higher than in Zones 2 and 3, which only had 299 and 572 individuals, respectively.

Although most of the morphospecies were in Zone 1, two were absent: *Carabidae* sp. and *Scutigera* sp. The former only occurred in Zones 2 and 3, while the latter was exclusively found in Zone 2. In addition, there were 5 morphospecies that spanned all three cave zones. These morphospecies included: *T. tjampeanus, C. dammermani, Theridiosomatidae* sp., *Rhaphidophora* sp., and *Tipulidae* sp. (Figure 6).

Even though 5 morphospecies occurred in all cave zones, their abundance in each zone differed (Figure 7). *Trachyjulus tjampeanus* contributed the most incredible abundance in all three zones. However, more than half of the individuals were situated in Zone 1. *Theridiosomatidae* sp. and *Tipulidae* sp. showed a similar pattern, with the highest abundance in Zone 1, followed by Zones 2 and 3. In contrast, *Rhaphidophora* sp. was most abundant in Zone 2, while Zones 1 and 3 possessed relatively equal numbers of individuals. Meanwhile, *C. dammermani* was relatively evenly distributed across cave zones.

3.3. Distribution of Obligate Cave Species

The troglobitic isopod *Philosciidae* sp. occurred in two specific sites in Zones 1 and 2 (Figure 8). four individuals of this cave obligate species were documented: three individuals in Zone 1 and one in Zone 2. Individuals were discovered in a similar microhabitat in both sites, a guano pile from insectivorous bats situated on a rock surface on the cave floor.

3.4. Community Structure of Macroarthropods

Ecological indices varied among cave zones (Table 3). With only 8 morphospecies, Zone 2 contained

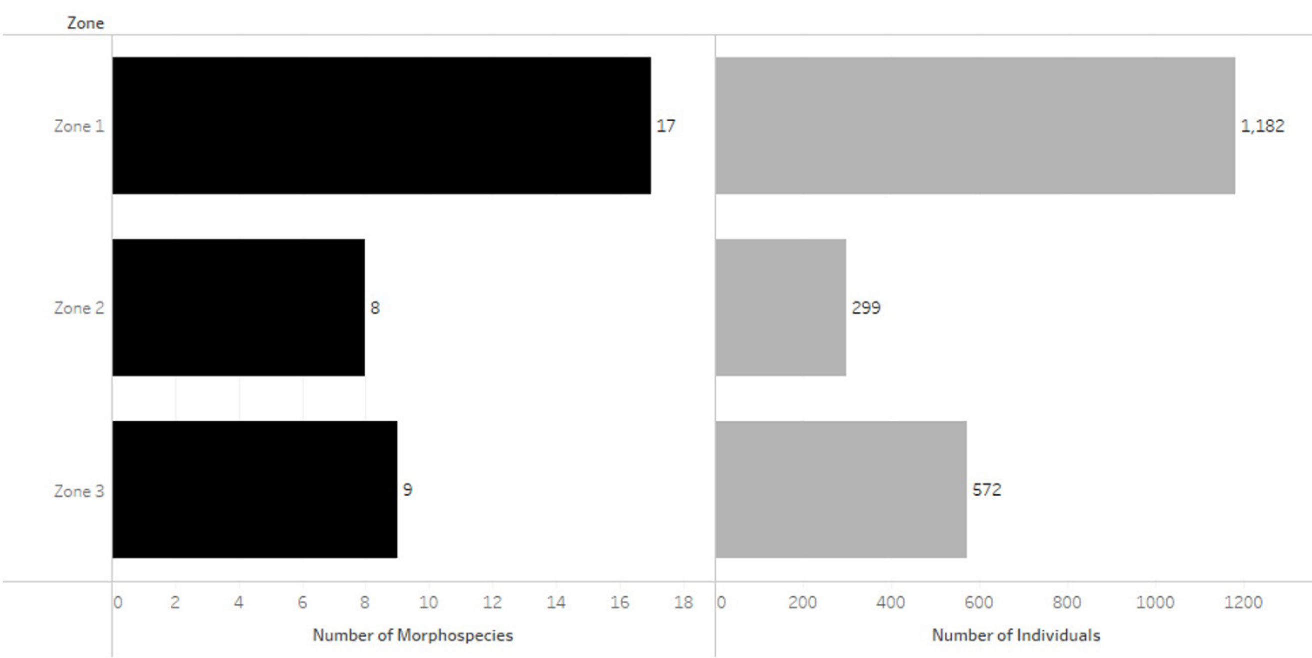

Figure 5. The number of morphospecies and individuals across zones in Cikarae Cave, Klapanunggal Karst, Bogor Regency, West Java

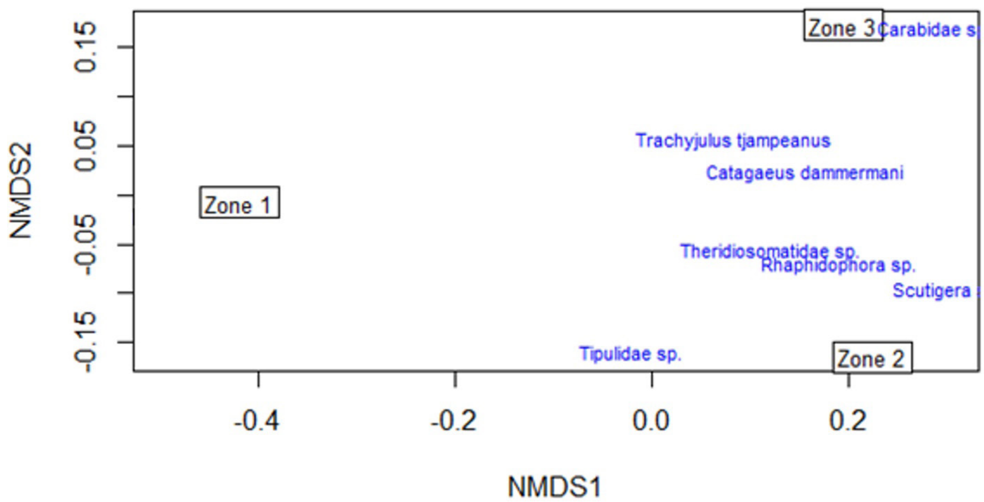

Figure 6. NMDS output illustrates morphospecies distribution across three zones in Cikarae Cave, Klapanunggal Karst, Bogor Regency, West Java

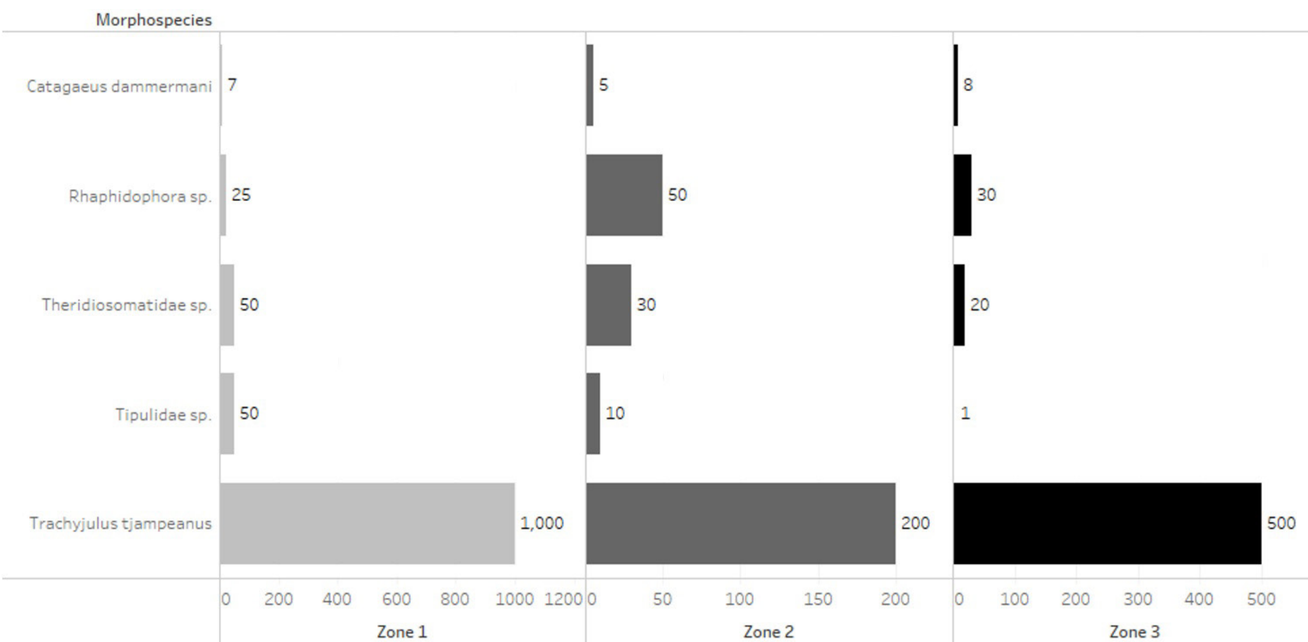

Figure 7. The abundance of morphospecies occurring in all sampling sites (Zones 1–3) in Cikarae Cave, Klapanunggal Karst, Bogor Regency, West Java

the lowest species richness compared to the other sites. However, the Shannon-Wiener diversity index measurement showed the opposite. Zone 2 scored highest on the diversity index, followed by Zones 1 and 3. In line with diversity, Pilou's evenness score in Zone 2 was also higher compared to Zones 1 and 3, which had relatively similar scores. In contrast, Simpson's dominance index was higher in Zones 1 and 3. Overall, Cikarae Cave possessed a low diversity index (0.782) and evenness (0.265), while the dominance score was relatively high (0.692).

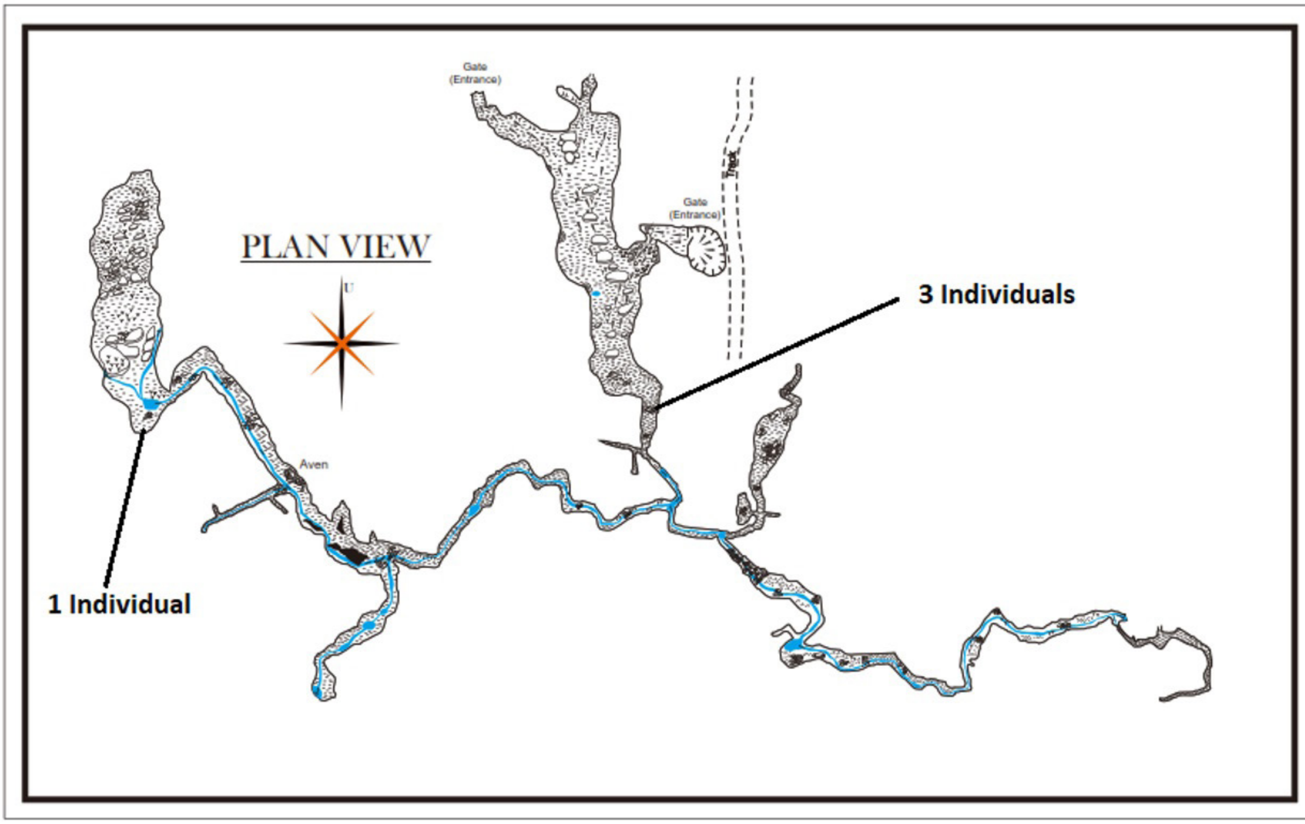

Figure 8. Distribution of the troglobitic isopod, *Philosciidae* sp., in Cikarae Cave, Klapanunggal Karst, Bogor Regency, West Java

Table 3. Ecological indices of macroarthropods across sampling sites in Cikarae Cave, Klapanunggal Karst, Bogor Regency, West Java

Sampling site	Diversity	Evenness	Dominance
Zone 1	0.728	0.257	0.720
Zone 2	1.052	0.506	0.487
Zone 3	0.574	0.261	0.768
Total	0.782	0.265	0.692

4. Discussion

Cikarae Cave represents a remarkable trove of macroarthropod diversity. Based on the taxa represented, the cave is considered one of Java's richest and most complete caves. All recorded classes and orders are well-known for colonizing caves (Romero 2009; Silva *et al.* 2020). Moreover, most morphospecies are widely documented from other caves in Java. Yet, the morphospecies *Carabidae* sp., *Armadillidae* sp., and *Philosciidae* sp. are scarcely found in other caves (Rahmadi 2008). According to previous reports, Insecta and Arachnida commonly appear as the most diverse cave groups (Silva and Ferreira 2015; Pellegrini and Ferreira 2016; Pacheco *et al.* 2020). However, in Cikarae Cave, Diplopoda supplanted Insecta as the second most diverse taxa. Most diplopods occurred exclusively in Zone 1, close to the cave entrances. Notably, they did not exhibit any troglomorphic traits. The Diplopods indicate that they may also live in the surface habitat of surrounding environments.

In this study, decomposers were dominant in terms of richness and abundance. This result corresponds with previous studies that reported the same (Kurniawan *et al.* 2018a). Decomposers are the base of cave food webs. They act as an important energy channel, bringing organic matter–mainly guano, carcasses, and plant litter–to upper trophic levels (Culver and Pipan 2009; Ferreira 2019; Campbell *et al.* 2021). *Trachyjulus tjampeanus* and *Rhaphidophora* sp. are the two most familiar decomposers widely distributed in Javan caves (Rahmadi 2011; Kurniawan *et al.* 2022b). They are well adapted to living in cave habitats and using bat guano as their food source (Kurniawan *et al.* 2020; Prakarsa *et al.* 2021). Thus, their abundance is significantly higher than other decomposers.

Predatory species commonly have smaller population sizes than most decomposers. However, some spiders can be abundant in caves, usually those with small body sizes. *Theridiosomatidae* sp. is an example of this case. Theridiosomatid spiders are well-known to live in dark and humid habitats (Jocque and Dippenaar-Schoeman 2006). Many studies confirm that the family has many cave representatives (Lin *et al.* 2014). All *Theridiosomatidae* sp. individuals in this study were highly specialized living on cave walls. They arranged spider webs in crevices along cave walls to catch their prey, mainly flying insects (Prete *et al.* 2018). Tropical caves with abundant bat guano are commonly rich in flying insect larvae, such as Diptera, Lepidoptera, and Coleoptera (Pellegrini and Ferreira 2013; Kurniawan *et al.* 2018b). This might be why several spider species with webs exist in caves, as the adults of these insects appear to be the prey.

Most morphospecies recorded in this study were classified as troglophiles, meaning they can complete their life cycle in caves or surface environments (Trajano and de Carvalho 2017; Mammola 2019). Almost all previous cave-dwelling animal inventories resulted in the dominance of troglophiles or trogloxenes (mainly bats and other vertebrates) over troglobites (Mazebedi and Hesselberg 2020; Silva *et al.* 2020). Troglobite species are relatively scarce and have not been recorded in all caves. Interestingly, a potential troglobite species, *Philosciidae* sp., was recorded in Cikarae Cave. Eye reduction and depigmentation exhibited by this morphospecies (Figure 4) are among the typical regressive adaptations of cave-dwelling animals (Huber 2018). Isopoda is one of the most common taxa contributing to troglobitic diversity. Many troglobitic isopods have been recorded in aquatic and terrestrial habitats worldwide, most highly associated with guano piles (Romero 2009; Fernandes *et al.* 2019; Ferreira 2019). The discovery of a troglobite is an essential finding in this study. The only two previous records of troglobites from Klapanunggal are stygobites that live in aquatic habitats, namely the isopod *S. javanicus* and a blind fish from the family Cyprinidae, which is still awaiting description. The existence of troglobitic species, therefore, makes Cikarae Cave an important cave ecosystem since it houses all ecological categories of cave-dwelling fauna.

Within Cikarae Cave, each species had specific microhabitat preferences in each cave site. Zone 1 contained the highest species richness due to its location near the entrances. Most morphospecies from Zone 1, mainly diplopods and spiders, were recorded close to the entrance and never found at deeper sites in the cave. Cave entrances act as an ecotone of cave and surface environments and are typically colonized by both cave and surface species (Prous *et al.* 2004, 2015). Thus, richness at the cave entrance is generally higher than in more profound passages (Tobin *et al.* 2013; Mammola 2019). This is confirmed by the significantly lower richness of Zones 2 and 3, which are located far from the entrances in Cikarae Cave. Macroarthropod abundance in Zone 1 was also higher because *T. tjampeanus*, the main contributor to abundance, was significantly more abundant in this zone. This species relies on fresh bat guano as its main diet (Kurniawan *et al.* 2020). Even though guano deposits were available in all three zones, the amount of fresh guano was highest in Zone 1. In addition, most of Zone 1 was terrestrial, supporting terrestrial species.

Several species occurred in all three cave zones (Figure 6), indicating they are the most successful morphospecies. Their abundance differences across cave zones reflect their habitat preferences (Figure 7). Several climatic and edaphic factors can cause this pattern. Kurniawan *et al.* (2018b) and Mazebedi *et al.* (2020) discovered an abundance gradient for the most abundant taxa among several sites located at different distances from the entrance. This gradation was a result of differences in abiotic factors, such as soil pH, moisture, electrical conductivity, relative humidity, CO_2 level, and light intensity. However, these studies were conducted in dry caves with limited water. In contrast, most of Cikarae Cave's floor, particularly Zones 2 and 3, is covered by water, which can influence terrestrial macroarthropod distribution. Therefore, most morphospecies prefers cave walls over wet floors in Cikarae Cave (Figure 2c).

Obligate cave species are known to prefer specific microhabitats in the dark zone of a cave (Tobin *et al.* 2013; Howarth and Moldovan 2018b). Even though most individuals of the troglobitic isopod *Philosciidae* sp. were found in Zone 1, their microhabitat was located in the deepest part of the zone (Figure 8), where conditions were dark and humid. This morphospecies was exclusively found in a specific substrate, namely a guano deposit from insectivorous bats situated on a rock surface on the cave floor. This morphospecies likely utilizes guano as its diet. In line with this finding, previous reports have revealed that isopods are a frequent component of guano communities (Ferreira 2019; Campos-Filho *et al.* 2020).

Cikarae Cave's low diversity and evenness scores result from high species dominance. Domination by adaptive taxa, particularly troglophiles, is evident in cave ecosystems. Millipedes (Spirostreptida: Cambalopsidae), cave crickets (Orthoptera: Rhaphidophoridae), and roaches (Blattodea) are some of the most successful troglophiles that colonize terrestrial cave habitats (Kurniawan and Rahmadi 2019; Kurniawan *et al.* 2020; Mazebedi and Hesselberg 2020). In this study, Zone 2 contained the highest diversity and evenness scores due to the lower abundance of the millipede, *T. tjampeanus.* Despite its remarkably large population, this species was unsuccessful in colonizing a chamber at the end of Zone 2 (Figure 1). Only a few individuals of this species were recorded at this site. It is a peculiar finding since the chamber was a completely terrestrial habitat, and guano was available. In contrast, cave crickets (*Rhaphidophora* sp.), another guano consumer, were surprisingly abundant. Food competition between these two species is very unlikely since guano does not appear to be a limiting resource. Further assessment is necessary to give a robust explanation.

In conclusion, Cikarae Cave hosts a diverse and abundant cave-dwelling macroarthropod community. In total, 19 morphospecies and 2,052 individuals of macroarthropods were successfully recorded. Morphospecies were distributed unevenly across cave zones, with most species occurring in the zone closest to the cave's entrances. Five morphospecies occupied all three zones but with different abundances. Decomposers dominated the community, and the vast majority of morphospecies occurred on cave walls. *Trachyjulus tjampeanus, Rhaphidophora* sp., and *Theridiosomatidae* sp. were the most abundant and easily found morphospecies. The domination of these morphospecies resulted in low diversity and evenness scores. We documented a new potential troglobitic species (Isopoda: Philosciidae) that occupied a specific habitat and exhibited a high degree of troglomorphy. Further investigation into the taxonomy and ecology of this troglobite is needed to describe its taxonomic and conservation status.

Conflict of Interest

The authors declare no conflict of interest in this research.

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