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Exploration of biodiversity and evenness of bryophytes in mount of bogor, Indonesia

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ABSTRACT

The geographical circumstances and rainfall in Bogor, Indonesia, contribute to the region's vast diversity of bryophyte. There aren't many studies that show the diversity of Bryophyta in the mountains. The study focuses on the exploration of Bryophytes in Curug Cilember and Curug Ngumpet to compare their diversity and evenness levels. The method used is an exploration method with purposive sampling. The results have identified 21 Bryophyte species in Mount Hambalang and 9 species in Mount Bunder. The analysis of diversity index in Mount Bunder and Mount Hambalang generated a value of 2.838 and 1.992, respectively. These values are within the criteria of moderate diversity. The evenness index for both areas is 0.932 and 0.906, respectively, which indicates a high evenness. The differences in the research are due to differences in environmental factors, consisting of temperature, humidity, and light index in both locations.

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INTRODUCTION

Bogor Regency has a varied topography. Most of its area is highland, hills, and mountains with an average temperature of 10-18 C; therefore, the area's air humidity is high, making it an ideal place for various plant species to grow. Bogor Regency is also known for its natural tourism areas, such as the waterfall or *curug* that can be found in mountain areas of the National Park, namely Mount Halimun Salak, National Park and Mount Gede Pangrango National Park, Indonesia (Rosiyanti & Susilowati, 2017). The exploration of moss variety in the mountains of Bogor, Indonesia, is urgent. Bogor's mountainous locations, such as Mount Salak and Mount

Gede-Pangrango, support a diverse range of mosses (Ristanto et al., 2021). Exploration can find new or unusual species that require conservation efforts before becoming extinct as a result of environmental changes or human activity (Sigit et al., 2022).3

Bryophytes are plants that can live in humid environments with temperatures ranging from 15 to 25 degrees Celsius (Tjitrosoepomo, 1998). Moss is critical to ecosystem balance and long-term sustainability in mountainous environments (Ristanto et al., 2021). These tasks include humidity regulation, erosion prevention, oxygen production, air quality indicators, and the development of new habitats (Endang et al., 2020; Lestiani et al., 2021; Windadri & Susan, 2013). Several environmental factors affect their growth, including humidity, temperature, and light. These environmental factors will affect species composition, adaptation levels, and distribution of Bryophytes according to their tolerance (Lestiani et al., 2021; Mulyani et al., 2014; Pasaribu et al., 2014). Ecologically, Bryophytes play a vital role in, for example, the high productivity and accumulation of biomass in ecosystems, nitrogen fixation, nutrient cycles, acting as producers in food chains and animal interactions, symbiosis with fungi, and the formation of lichen (Bates 2000, 2009; O'Neill 2000; Vitt & Wieder 2009).

High-humid environment is usually located in tropical rainforest areas (Sopacua et al., 2020). One of these environments is Curug Cilember in Mount Hambalang in the Mount Halimun Salak National Park and Curug Ngumpet in Mount Bunder in the Mount Gede Pangrango National Park. A previous study in the Mount Halimun Salak National Park by Marhento & Zaenab (2020) in the Mount Kendeng area found 16 species of Epiphytic Bryophytes with a diversity index of 2.149. Another study in the Pameungpeuk area by Windadri (2017) found 78 species of mosses (*musci*) with 47 genera and 20 families. Pasaribu et al. (2022) state that 15 Bryophyte species were found in the area of Mount Gede Pangrango National Park, particularly in the area of Situ Gunung natural tourism site. *Polythricum commune, Marchantia* sp., and *Dumortiera hirsuta* are the most frequently found species of Bryophytes in the research. The examination results indicate that no research has been done related to Bryophyte diversity and evenness in Curug Cilembmer in Mount Hambalang and Curug Ngumpet in Mount Bunder. Thus, the current study aims to gain information on the existing Bryophyte classification, abundance and density of each Bryophyte species, and diversity index and evenness index of Bryophyte in two locations, namely Curug Cilember in Mount Hambalang and Curug Ngumpet in Mount Bunder, Bogor.

RESEARCH METHODS

Research Design

This study used the exploration approach, which involves tracing and defining the sampling region (Sedayu et al., 2019). This research is descriptive and employs a quantitative technique. The initial step of the research was determining the research locations. Data collection was carried out at two different sites, namely Mount Hambalang and Mount Bunder. Two stations will be established in those locations along the path to the waterfalls.

Figure 1. Map of Mount Bunder and Mount Hambalang Areas

Figure 1. Map of Curug 7 Cilember in the Mount Hambalang Area

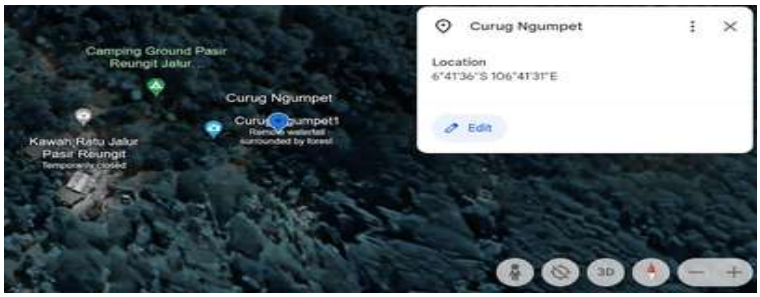

Figure 2. Map of Curug Ngumpet in Mount Bunder[R1] Area

The research consisted of several stages. The first stage was research planning, consisting of determining the formulation of problems, samples, places, tools, and materials to be used in the research. The second stage was field observations to determine locations for data collection stations. The third stage was data collection using the exploration technique by exploring and determining sampling areas in the stations.

The collection of Bryophytes was carried out in an observatory station located in several sites based on their environmental tone (stratified random sampling). This research was conducted in two stations in different mountains. Station 1 was in Curug 7 Cilember in Mount Hambalang, and Station 2 was in Curug Ngumpet in Mount Bunder. The research used quadratic plots of 50x1 m in size with 3 transect points, with a length of 450 m.

Population and Samples

The research population was all Bryophyte species in the Mount Hambalang and Mount Bunder areas, Bogor, Indonesia. The research samples included all Bryophyte plants observed in the quadratic plots in each mountain area. Figure 1 and 2 describes the moss sampling locations.

Instruments

The research instruments were observation sheets. Two observation sheets were used in the research, one was for the number of Bryophyte individuals in each substrate (Tables 1 and 2) and the other was for environmental factor data.

Procedures

The initial step carried out in the research was determining Bryophyte sampling locations. The research locations were Curug Cilember in the Mount Hambalang area and Curug Ngumpet in the Mount Bunder area. One station was set in each area. A quadratic plot of 50x1 m with 3 transect points along 450 m was established. Samples were taken from the determined locations for Bryophytes that attached to trees, soil, and rocks. Bryophytes found in the locations were photographed for identification. Next, the environmental parameter measurement was carried out around the mountain areas. The Bryophyte samples found were identified by observing their

morphological characteristics and environmental parameters such as temperature, light intensity, and air humidity. The next step after the identification was calculating the density by adding up all individuals per unit of area or unit volume. Data gained were analyzed for their abundance and diversity. The Shannon-Wiener's index generated will be used as a comparison to identify the diversity level of Bryophyte species.

Data Analysis

The research data analysis was generated from data that were descriptively analyzed and presented in the form of pictures. Microscopic observation was carried out to identify Bryophyte species in terms of the shape, conditions, and substrates, and then matched them with the identification book. The following are the data analysis and statistical analysis methods employed in the study. The number of taxa discovered was examined to demonstrate the composition of Bryophytes. Population density was determined by calculating the species of liverworts/mosses or hornworts (Ind/m2) at each observation site. Shannon-Wiener's Diversity Index was used to calculate the diversity of the Bryophytes. Kandeigh's dominance Index (1980) was used in the study to show a community's relative abundance. Odum (1971) used the Evennes Index formula to calculate bryophyte evenness.

RESULTS

The results of the research and identification data from the exploration in the two locations found 21 species from 15 families in Curug Cilember in Mount Hambalang as presented in Table 1. The location has an average temperature of 23°C, average humidity of 92%, and average light intensity of 1002 lx.

Table 1. Bryophytes found in Curug Cilember Gunung Hambalang

No	Classification		Substrate		
	Class	Species	Soil	Rock	Tree
1.	Musci (Mosses)	*Andreaea petrophila*	-	+	-
		Fontinalis antipyretica	-	+	-
		Fissiden's taxifolius	+	+	+
		Fissidens oblongifolius	+	+	+
		Plagiomnium affine	+	-	-
		Mnium hornum	-	+	+
		Cyathophorum bulbosum	-	+	-
		Plagiothecium nemorale	+	-	-
		Plagiothecium curvifolium	+	-	-
		Taxiphyllum sp	-	+	+
		Hypnum cupressiforme	+	+	-
		Thuidium ramariscinum	+	+	-
		Homolothecium fulgescens	-	+	+
2.	Hepaticae (Liverworts)	*Conocephalus conicus*	+	+	-
		Lunularia cruciata	+	+	-
		Metzgeriaceae sp	+	-	-
		Marchantia emarginata	-	+	-
		Marchantia sp	+	+	-
		Marchantia polymorpha	+	-	-
3.	Anthocerotae (Hornworts)	*Anthoceros punctate*	-	+	-
		Anthoceros laevis	-	+	-

In the second location, Curug Ngumpet in Mount Bunder, the researchers identified 9 species from 6 families as indicated in Table 2. The location has an average temperature of 25°C, average humidity of 85%, and average light intensity of 1312 lx.

Table 2. Bryophytes found in Curug Ngumpet, Gunung Bunder.

No	Classification		Substrate		
	Class	Species	Soil	Rock	Tree
1	Musci (Mosses)	*Dicranum scoparium*	+	+	+
		Hypnum cuppreniforme	+	+	-
		Vesicularia montagnei	+	+	-
		Pogonatum sp.	+	+	-
		Polytrichum commune	+	+	-
2	Hepaticae (Liverworts)	*Pallavicinia lyelli*	+	+	-
		Symphyogyna sp.	+	+	-
		Marchantia polymorpha	+	+	-
3	Anthocerotae (Hornworts)	*Anthoceros sp.*	+	+	-

Tables 3 and 4 present the calculation results of the Bryophyte density and abundance in the Curug Cilember and Curug Ngumpet. The Bryophyte density and abundance were calculated from the number of colonies in each species.

Table 3. Density, Abundance, Diversity Index (H') and Evenness Index (E') of Bryophytes in Curug Cilember

No.	Species	Density (Pi)	Abudance
1	*Andreaea petrophila*	0,049	4,9%
2	*Funtinalis leptocladus*	0,011	1,1%
3	*Fissidens perpussillus*	0,089	8,9%
4	*Fissidens oblongifolius*	0,085	8,5%
5	*Plagiomnium affine*	0,074	7,4%
6	*Mnium hornum*	0,093	9,3%
7	*Cyathophorum bulbosum*	0,087	8,7%
8	*Plagiothecium nemorale*	0,017	1,7%
9	*Plagiothecium curvifolium*	0,018	1,8%
10	*Taxiphyllum sp*	0,087	8,7%
11	*Hypnum cupressiforme*	0,087	8,7%
12	*Thuidium ramariscinum*	0,018	1,8%
13	*Homalothecium fulgescens*	0,052	5,2%
14	*Conocephalum conicum*	0,006	0,6%
15	*Lunularia cruciata*	0,046	4,6%
16	*Metzgeriaceae sp*	0,003	0,3%
17	*Marchantia emarginata*	0,040	4%
18	*Marchantia sp*	0,003	0,3%
19	*Marchantia polymorpha*	0,073	7,3%
20	*Anthoceros punctatus*	0,002	0,2%
21	*Anthoceros laevis*	0,060	6%

Table 4. Density and Abundance of Bryophytes in Curug Ngumpet

No.	Species	Density (Pi)	Abudance
1	*Dicranum scoparium*	0,418	42%
2	*Hypnum cuppreniforme*	0,033	3,3%
3	*Vesicularia montagnei*	0,040	4%
4	*Pogonatum sp.*	0,008	0,8%
5	*Polytrichum commune*	0,009	0,9%
6	*Pallavicinia lyelli*	0,074	7,4%
7	*Marchantia polymorpha*	0,166	17%
8	*Symphyogyna* sp.	0,097	9,7%
9	*Anthoceros sp.*	0,151	15%

Table 5 presents the calculation results of the diversity index (H') and evenness index (E) of Bryophytes in the two exploration locations. The calculation of the diversity index value employed the Shannon-Wiener formula.

Table 5. Diversity Index (H') and Evenness Index (E') of Bryophytes in Curug Cilember and Curug Ngumpet.

No	Location	Diversity Index (H')	Evenness Index (E')
1	Curug Cilember, Mount Hambalang	2,838	0,932
2	Curug Ngumpet, Mount Bunder	1,992	0,906

Based on Table 1, Bryophytes identified in Curug Cilember were classified into 15 families consisting of 10 families of Musci (mosses), 4 families of Hepaticae (liverworts), and one family of Anthocerotae (hornworts). Contrary, Bryophytes identified in Curug Ngumpet as presented in Table 2 were 6 families comprising 3 families of Musci (mosses), 2 families of Hepaticae (liverworts), and one family of Anthocerotae (hornworts).

The diversity and evenness of Bryophytes in the two exploration locations were varied. The diversity index value was higher in the Curug Cilember, Mount Hambalang than in Curug Ngumpet. Additionally, both locations indicated a high evenness index suggesting a stable Byrohyte community in both observation locations.

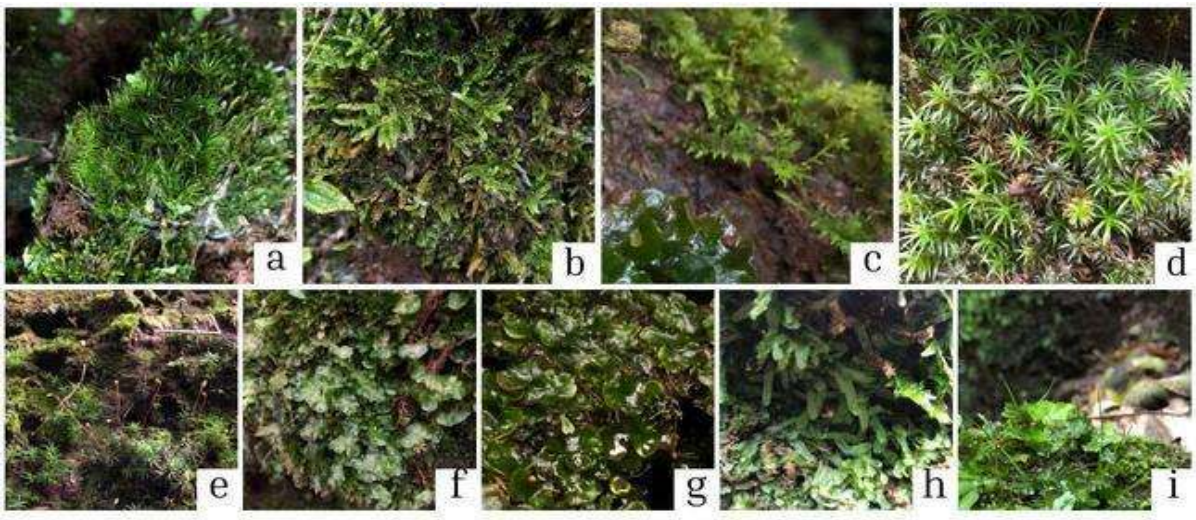

Figure 3. Bryophyte species identified in Curug Ngumpet. (a)*Dicranum scoparium (b) Hypnum cuppreniforme, (c) Vesicularia montagnei, (d) Ponogatum sp, (e) Polytrichum commune, (f) Pallavicinia lyellii, (g) Marchantia polymorpha, (h) Symphyogyna* sp., *and (i) Anthoceros sp.*

Figure 4. Bryophyte species identified in Curug Cilember. (a)*Andreaea petrophila (b) Funtinalis leptocladus, (c) Fissidens perpussillus, (d) Fissidens oblongifolius, (e) Plagiomnium affine, (f) Mnium hornum, (g) Cyathophorum bulbosum, (h) Plagiothecium nemorale, (i) Plagiothecium curvifolium, (j) Taxiphyllum sp, (k) Hypnum cupressiforme, (l) Thuidium ramariscinum, (m) Homalothecium fulgescens, (n) Conocephalum conicum, (o) Lunularia cruciata, (p) Metzgeriaceae sp, (q) Marchantia emarginata, (r) Marchantia sp, (s) Marchantia polymorpha, (t) Anthoceros punctatus, and (u) Anthoceros laevis* .

DISCUSSION

Identification and Morphology of Bryophytes

Referring to data gained in the research, 21 species of Bryophytes were found in the area of Cilember Waterfall, Mount Hambalang consisting of 10 families of mosses, 4 families of

liverworts, and 1 family of hornworts. The family of mosses identified included *Andreaeaceae* (1 species: *A. petrophila*) , *Fontinalaceae* (1 species: *F. antipyretica*), *Fissidentacea*e (2 species: *F. taxifolius, F. oblongifolius*), *Mniaceae* (2 species : P*. affine, M. hornum*), *Hypterygiaceae* (1 species : *C. bulbosum*), *Plagiotheciaceae* (2 species : *P. nemorale, P. curvifolium*), *Taxiphyllaceae* (1 species : *Taxiphyllum sp.*), *Hypnaceae* (1 species: *H. cupressiforme*), *Thuidiaceae* (1 species: *T. ramariscinum*), and *Brachytheciacea*e (1 species: *H. fulgescens*). The liverworts consisted of 4 families, namely *Conocephalaceae* (1 species: C. *conicum*), *Lunulariaceae* (1 species: *L. cruciata*), *Metzgeriaceae* (1 species: *Metzgeria sp.*), and *Marchantiaceae* (3 species: *Marchantia sp., M .emarginata, M. polymorpha*), and the hornworts found was from *Anthoceroceae* (2 species: *A. laevis, A. punctatus*).

In the second location, Ngumpet Waterfall in Mount Bunder, 9 families of Bryophytes were found consisting of 3 families of mosses, namely *Dicranaceae* (1 species: *D. scoparium*), *Hypnaceae* (2 species: *H. cupperniforme and V. montagnei*), *Polytrichaceae* (2 species: P*onogatum sp. P. common*); 2 families of liverworts from the *Pallaviciniaceae* (2 Species: *P. lyellii and Symphyogyna* sp.), *Marchantiaceae* (1 species: *M. polymorpha*), and *Jungermanniaceae* (1 species: *J. hodgsonii*); and the hornworts found was from the family of *Antherotaceae* (1 species: *A. laevis).*

The species of (a)*Andreaea petrophila* was found in Curug Cilember. The Bryophyte colonies were found on rock substrate. The mosses grow in an environment that has low humidity and high sun exposure. *(b) Funtinalis leptocladus* or known as "liver moss*"* is a moss with a light green color found in a habitat near freshwater sources. These Bryophytes have the characteristics of round leaves and prominent veins. They were found in Curug Cilember (Dahl, 2021). The genus Fissidens was found in a sufficient number in the Curug Cilember area. Species in this genus have characteristics of green-yellow to golden brown plants, and simple (Budke, et al., 2023). Two species from this genus were found on the tree and moist soil substrates, namely *(c) Fissidens perpussillus* and *(d) Fissidens oblongifolius. (e) Plagiomnium affine:* this Bryophyte has characteristics of round leaves with light to dark green color and a slippery and transparent texture due to its frequent exposure to water. This type of Bryophyte is found in moist soil under trees in high rainfall conditions. *(f) Mnium hornum* is a Bryophyte species with the highest density in Curug Cilember. This Bryophyte is often found on damp tree trunks. It has an upright stem 1.5–5 cm high, reddish in color, and often gracefully curved. It has leaves that are about 4 mm long with serrated edges. It often produces capsules at the end of stalks 2.5–5 cm long. The capsules have pointed tips (Klips, 2022). *(g) Cyathophorum bulbosum* is a Cyathophorum species that has an unbranched stem but its distal leaves are arranged in two lateral rows with a ventral row. During the exploration, this species was found growing on rotting wood and moist soil substrates. During the observation, a Bryophyte from the genus *Plagiothecium* was found. This Bryophyte is a large plant, yellowish green in color, and without metallic luster. The stem is 2.5-3 cm, has a complanate foliation, and a rounded cross-section. *Lagiothecium* is a cosmopolitan genus found in all continents, but it is rarely found in Asia and Europe (Wolski, et al., 2021). Other species found during the exploration included *(h) Plagiothecium nemorale, (i) Plagiothecium curvifolium,* and *(j) Taxiphyllum sp*. These species are typically found on logs or rotten wood. During the observation, these Bryophytes covered tree trunks with their bright yellow-green thallus color. These types of Bryophytes have thin, single-celled leaves like animal fur (Wang dan Yu, 2019). *(k) Hypnum cupressiforme* was found in both observation sites. This Bryophyte has characteristics of green color with small thallus. During the observation, this Bryophyte was found on moist rock substrates. *(l) Thuidium ramariscinum* is a small, flat plant with colors ranging from yellow to dark green. Its branches are arranged, more or less, in one plane and become shorter towards the end of the shoot. *m) Homalothecium fulgescens* was found in humid and slightly shaded environments. In the Curug Cilember, this Bryophyte was found on tree stems with characteristics of yellowish green

in color with irregular branching shoots growing loosely, ascending in tufts or as spreading stems. *(n) Conocephalum conicum* is a liverwort found along rocky roads during the observation. Its leaves are shiny with a bright-colored wide thallus (Sukmawati, 2023). *(o) Lunularia cruciata* was found in dense colonies. This Bryophyte is green with a wide thallus and wavy edges. It is usually found on moist soil substrates and is usually attached to rocks or concrete. *(p) Metzgeriaceae sp.* was found on moist soil and lived side by side with many Bryophytes. Species in this genus have branched thallus and are small and transparent (So, 2004). Genus Marchantia is a group of liverwort that is easy to find in Indonesia. This species has the characteristics of a dark green body with flat edges and dichotomous branches (Febriansah, *et al.,* 2019). Other species found included *(q) Marchantia emarginata, (r) Marchantia sp, (s),* and *Marchantia polymorpha.* A group of hornworts was also found in Curug cilember. The thallus of the hornworts is relatively thin with wavy edges (Sasongko, dkk, 2020; Hassel, et al. 2018). During the observation, species from the hornwort group were found in moist soil substrate, namely *(t) Anthoceros punctatus,* and *(u) Anthoceros laevis*.

Several Bryophyte species were also found in Curug Ngumpet, some of the species were similar to those found in Curug Cilember, such as *Marchantia polymorpha, Anthoceros sp,* and *Hypnum cupressiforme.* (a)*Dicranum scoparium*: was found on rocks and tree trunks. The leaves are green and have a pointed shape like a spear with a long and thin tip. *(c) Vesicularia montagnei* has a small pine-like morphology. Its stem is slim and elongated with a shape resembling a Christmas tree with green leaves. It is commonly found in moist soil. *(d) Ponogatum sp:* this type of Bryophyte is a plant that grows upright with a stem, and leaves that are one layer cell thick, and often has central veins with septed branched rhizoids. During the observation, these Bryophytes were found in colonies with moist soil substrate. *e) Polytrichum commune,* this species was found near water sources and has wide colonies. Its substrates are moist soil and tree trunks. It has leaves that spread like stars. *(f) Pallavicinia lyellii,* this type of Bryophyte is one of Bryophytes that is classified as a thallus liverwort. Pallavicinia lyelli has dark green gametophyte and does not have leaves like in most Bryophytes but it has thallus. The thallus has white veins with wavy edges. The growing substrate of this species is in moist soil. *(h) Symphyogyna* sp., this Bryophyte is also called thallus liverwort since it has a body in the form of thallus. When it was found, the gametophyte of Symphyogyna sp. is like a thin, watery green ribbon that grows creepingly on the substrate, namely on the soil. Several Bryophytes found in the observation locations were in their gametophyte phase; however, some individuals are in the haploid phase. The observations were carried out during the rainy season; thus, the conditions of the Bryophytes in the locations were fresh and not dry.

Density and Abundance of Bryophytes.

Based on the research results in Table 3, the Bryophyte species with the highest density and abundance in Curug Cilember was mosses from the family *Mniaceae*, namely *Mnium hornum*. *M. hornum* is a mid-sized leavy Bryophyte. This species has a stem of 1.5-5 cm in height. The leaves are oblong-lanceolate to lingulata with a length of 3-6 mm, nearly conical to the apex, bordered by linear cells that contrast sharply with the equilateral and conspicuously doubly toothed cells along the margin. Sporophytes are fairly common, 1-2 cm tall, with a drooping cylindrical capsule (Klips, 2022). This species is commonly found in areas with high humidity and uses tree bark or rock as a substrate.

Based on the observation results in Curug Ngumpet, the highest abundance and density of Bryophytes was from the species *Dicranum scoparium*. Species from genus *Dicranum* have characteristics falcate-secon, narrow lanceolate to ovate-lanceolate, usually unistratose leaves; its entire leaf margin is serrate; costa is narrow below the current to smooth short current or with serrated ridges behind; laminal cells are subquadratic to elongate, thick walled, and often porous;

well-developed root cells and dicranum haplolepideus with a single row of teeth around the mouth of the capsule (Lang & Stech, 2014).

Based on the observation in both areas, Curug Cilember and Curug Ngumpet, the number of mosses (Musci) was larger than liverworts (Hepaticae) and hornworts (Anthocerotae). According to Fanani (2019), mosses are found in greater numbers than liverworts. This is due to the number of mosses in nature being greater than that of liverworts and hornworts. There are 1200 Bryophyte species identified in nature with varied morphology (Vanderpoorten dan Goffinet, 2009; Mulyani et al., 2015). True leafy mosses (Bryophyte) are categorized as having reached a higher stage of development compared to other Bryophytes where their stems and leaves are recognizable (Kartikasari, et al., 2023).

Diversity Index of Bryophytes.

Based on the calculation results in Table 3, the diversity index values of Bryophyte in Curug Cilember and Curug Ngumpet were 2.838 and 1, respectively. The difference in the diversity value was affected by the environment of the area, such as humidity, temperature, and sunlight intensity (So Seen dan Kurnia, 2021; Endang et al., 2020). Despite the difference, both locations had a moderate diversity level since the diversity index values were within the category of moderate diversity set by Shannon-Wiener, which is $1 \leq H' \leq 3$.

Evenness Index of Bryophyte.

The evenness index calculated and presented in Table 3 indicates that the evenness index values in Curug Cilember and Curug Ngumpet were 0.932 and 0.906, respectively. A low evenness index suggests that environmental obstacles have led to the dominance of many species at high density. Vice versa, a large index score indicates no species dominance and equal abundance for all species (Nashaat, 2019). Based on the evenness index that is close to one, the communities are considered stable since organisms are seen to be evenly distributed. Therefore, it can be stated that a species has an opportunity to preserve its respective species in that area (Madjeni et al, 2019).

Relationship between Abiotic Factors and Distribution of Bryophytes in Two Locations

Various factors affect the differences in the abundance, density, diversity index, and evenness index values. One of the factors is the environmental conditions. As indicated in Table 3, there are differences in the environmental factors in Cilember Waterfall in Mount Hambalang and Ngumpet Waterfall in Mount Bunder. Low temperature and high humidity are the supporting factors for the growth of Bryophytes and the numerous Bryophyte species. Wati et.al (2016) stated that Bryphytes tend to require a relative humidity of 70-98% to support their life. Higher humidity in Curug Cilember is a factor for the greater diversity of Bryophyte species in this location compared to Curug Ngumpet. Additionally, differences in light intensity in both locations led to differences in density, abundance, and diversity of species. According to (Sulistyowati et al., 2014) light intensity of 100 lux-1050 lux is sufficient to support Bryophyte growth. It can be concluded that Curug Cilember is a more ideal location for the growth of Bryophytes compared to Curug Ngumpet. Moreover, human intervention is included in the factors that affect the differences. In Curug Ngumpet, some exploration paths are asphalt roads that are frequently used by vehicles, making it difficult for Bryophytes to grow in the area.

CONCLUSION

The activity of Bryophyte exploration aims to identify Bryophyte diversity in two areas, namely Mount Bunder area and Mount Hambalang area, which have distinct Bryophyte diversity. The research results found 21 Bryophyte species from 15 families in Cilember Waterfall in Mount

Hambalang and 9 species from 6 families in Ngumpet Waterfall in Mount Bunder, Indonesia. The diversity index values obtained in the research are 2.838 in the Mount Hambalang area and 1.992 in the Mount Bunder area. Therefore, the diversity is within the moderate diversity criteria. Bryophytes found in both areas are affected by various factors, such as temperature, humidity, and light intensity. Based on the research results, further research is necessary for a wider and more diverse research area coverage to obtain more representative results. Moreover, the next research can compare the morphological characteristics of Bryophytes between the two areas due to distinct elevation, temperature, humidity, and light intensity.

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