Biodiversity of Division Bryophyta (True Moss) in Kapas Biru Waterfall Pronojiwo Lumajang

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Abstract

Indonesia has a wide variety of of moss plants. Approximately 1500-2000 types of true moss and liverworts are found in Indoensian territory. Moss are commonly found in humid habitats, in climatic conditions of tropical forests and waterfalls such as Kapas Biru Waterfall Pronojiwo Lumajang. This descriptive explorative study aimed to identify moss species found in Kapas Biru Waterfall Pronojiwo Lumajang. The sampling area was divided into 3 regions based on topography ie parking area, along the footpath heading towards the waterfall, and the area around the waterfall. The study was conducted using cruise method and plotting method. Several environmental factors such as temperature, air and soil humidity, soil pH, light intensity, wind velocity and elevation. The result showed that there are 13 species of mosses found belonging to 11 different families.

Keywords: *Biodiversity, Bryophyta, Kapas Biru Waterfall.*

1. INTRODUCTION

Biodiversity in Indonesia is quite high compared to other countries. The diversity of moss plant in Indonesia consists of 1500-2000 types of true mosses and liverworts. The amount represents 20% -30% of all types of moss (LIPI, 2015). Moss have a very important role for our life and our environment especially on the ecosystem. The moss community has many species and its richness is strongly influenced by external factors, such as water, light and temperature that makes the moss an efficient bio indicator for a change in environment (Lalhriatpuia, 2015). Moss can also produce oxygen (O2) through the process of photosynthesis and serve as a pollutant absorber. Although it is one of biodiversity which has many potential, moss is still neglected, not yet widely known and utilised for the sake of human benefit (Puniman, 2005). Existing and abundance moss plants in Indonesia have not been fully identified. Such circumstances may allow for extinction or loss of speciation and information on the diversity of moss plants. Species of moss plants exist in their natural habitat will decrease if many are not identified (Sungkar, 2006).

Plant identification is a process o to recognize the types of plants in detail and complete based on their specific characteristics, this process should be able to be accounted scientifically. The purpose of plant identification is to facilitate students, researchers or general society who require plant identity in the context of science dissemination.

Mosses are commonly found in trees, stones, logs and on the ground. They are almost present in every habitat except in the sea (Menih, 2006). Moss is found in terrestrial habitats and in aquatic habitats. These habitats are found in tropical forest climates. Environmental conditions in tropical forests and in damp climatic forest soils are ideal conditions and are commonly found in areas of moss-covered waterfalls. Steenis (2010: 67), states that waterfalls are common at elevations between 1000 and 2000 m. Waterfalls are typically surrounded by forests with diverse vegetation. The rock walls are not too steep,

also much overgrown mostly with moss and fern.

Waterfalls that have such an environment, still hold its natural surroundings is Kapas Biru Waterfall. This waterfall is located around the sleep of Mount Semeru in Pronojiwo Lumajang. Kapas Biru Waterfall preserved natural environment might be due to its limited access to human activity. This waterfall has been opened to public only recently with a strict limited access to certain location. Based on Lumajang District Regulation No. 1 of 2014 on Medium Term Development Plan of Lumajang Regency 2015-2019, Kapas Biru Waterfall has not been included in the list of tourism areas of Regency Lumajang. From these data it is necessary to have a preliminary research particulary on the diversity of flora and fauna in the area of Kapas Biru Waterfall (RPJMD, 2015).

Kapas Biru Waterfall is one of the unique destinations in Lumajang. The uniqueness of this waterfall because it is located on the slopes of Mount Semeru. To reach the location, visitor have to travel on foot for approximately ± 45 minutes (as far as ± 1.2 km). This area provides benefits to the environment around the mountains, it has cool forest climate, high humidity and fertile conditions (Tourism Office Lumajang, 2015). The area of Blue Cotton waterfall has many types of plants because of the cool climate of the forest so it has potential to contain many diverse moss plants. Preliminary site surveys have found a number of facts, among other are the types of plants in forest areas usually have a high canopy or a wide canopy. This allows this canopy to overshadow the surrounding vegetation. Shade plants that commonly found are mahogany, sengon and the like. Around the waterfall there are also bamboo and banana trees. Around the cliffs and rocks found bunches of moss and fern vegetations. This vegetation is influenced by shade tree species, humidity, microclimate and topography.

The purpose of this research is to identify all of moss species found in Kapas Biru Waterfall Lumajang

2. RESEARCH METHODS

This study is descriptive explorative research conducted in Kapas Biru Waterfall Area of Pronojiwo Lumajang. The sampling area was divided into 3 regions based on topography which are parking area, along footpath area heading towards the waterfall, and the area around the waterfall. The study was conducted using cruise method especially on sloppy area and plotting methods on plain area.

The cruise method was carried out by walking down the footpath using the path transect technique. The dimension of transect being used was 1x1 meter with the footpath as a centerpoint. Sample of moss was collected from the footpath then 1 meter down to right, left, forth and back directions. Upward sampling collection was obtained until 2 meters height. Moss plants that taken as samples can be attached to trees, cliff walls, rocks or soil. Sampling activity also carried out by considering the vegetation and hue of environmental surrounding conditions such as temperature, humidity, soil moisture, soil pH, wind velocity, light intensity and elevation.

The research was carried out within 8 stages namely preliminary observation, measurement of environmental factors, sampling collection, labelling, characterization and description, sample identification, and herbarium making.

The initial observation stage of the location was carried out to determine the presence or absence of moss plants in the location. Then the measurement of abiotic factor carried out around the 15 areas where moss was obtained. Next stage was sample collection followed by labelling and characterizing. Morphological decription was carried out before sample identification, the description provided information about the classification of each samples. Sample identification was done by sistimatically

naming to the genus level. Herbarium was the last stage done to provide ready-stock sample for further examination.

3. RESULT AND DISCUSSION

The results showed that there were 13 samples of Divisio Bryophyta obtained from Kapas Biru Waterfall. Sampling collection was conducted on January, 27th until February, 1st 2017. The identification of 13 samples was done in Laboratorium of Botany, Biology Education Study Program, Faculty of Teacher Training and Education University of Jember. The identification process referred to Encyclopedia of Plant Biology of Bryophyta by Suhono (2010). From the total of 13 samples, there were 5 unidentified samples. These samples then sent to Cibodas Botanical Garden Conversation (LIPI).

Moss spread over 3 area of sampling regions. Each area has vegetation of different moss plants. The observed moss data found in the 3 topographic sampling areas presented in Table 1.

Table 1. Bryophyta species in 3 regions of sampling area.

La-bel	Sample Name	Park area	Foot-path	Around wtrfall
B	*Herpetineuron toccoeae*	-	+	-
D	*Philonotis gracillima*	-	++	-
E	*Barbella horridula*	-	++	-
I	*Barbella flagellifera*	-	+	-
L	*Grimmia elongata*	-	++++	++
N	*Ectropothecium* sp	-	++	-
P	*Hyophila javanica*	-	+	-
Q	*Ectropothecium ichnoto-claadum*	-	+	-
R	*Bryium argenteum*	-	-	+
S	*Thuidium* sp	-	+	-
U	*Weissia edentula*	-	+	-
W	*Racopilum spectabile*	-	+	-
X	*Fissidens* sp	-	-	++

Study on Moss Biodiversity In Kapas Biru Waterfall Pronojiwo Lumajang has been done. Identification was done on samples of moss plants that have been found and made herbarium. The number of successful Bryophyta species identified by the World Encyclopedia of Plant Moss and the ITIS is 8, so that there are 5 species sent to Cibodas Bogor Botanical Garden - LIPI. The results showed that there were 13 species of Bryophyta in the area of Blue Cotton Waterfall divided into several families presented in Table 2.

Table 2. Families of Bryophyta found in Kapas Biru Waterfall.

Species	Family
Herpetineuron toccoeae	*Anomodontacea*
Philonotis gracillima	*Bartramiaceae*
Barbella horridula	*Meteoriaceae*
Barbella flagellifera	*Meteoriaceae*
Grimmia elongata	*Grimmiaceae*
Ectropothecium sp	*Hypnaceae*
Hyophila javanica	*Pottiaceae*
Ectropothecium ichnoto-claadum	*Hypnaceae*
Bryium argenteum	*Bryaceae*
Thuidium sp	*Thuidiaceae*
Weissia edentula	*Pottiaceae*
Racopilum spectabile	*Racopilaceae*
Fissidens sp	*Fissidentaceae*

Environment parameter measurements in the sampling area include temperature, humidity, soil moisture, soil pH, light intensity, wind speed, and altitude. Standardized instruments used to obtain data environmental were thermohygrometer for temperature and humidity, soiltester for pH and soil moisture,

Luxmeter for light intensity, anemometer for wind speed, and Altimeter for altitude.

The measurement of environmental parameters is done 3 times in each sampling area at a different time (morning, noon, afternoon). The average data measurement listed in Table 3.

Table 3. Average value of environment measurements

Abiotic Factors	Morn-ing	Noon	Aftrno-on
Air humidity	81.4	80.4	91
Soil humidity	55.9	47.5	47.7
Temperature	22.7	26	24.8
Wind speed	32.8	176.7	71.1
Soil pH	6.6	6.7	6.2
Light intensity	4195.3	13234.1	1398.3

There are 13 species of Divisio Bryophyta found in Kapas Biru Waterfall. they are commonly found along the footpath and around the waterfall. True moss found in the temperature range 22.73°C in the morning, 26°C in daytime, and 24.83°C in the afternoon. Specific moss species such as *Grimmia elongata* Kaulf. in J. Strum is found in many areas from the footpath to the area around the waterfall.

The temperature of the environment affects the spread of the moss. Elevated elevation will cause a decrease in ambient temperatures. Along with the rising in elevation, temperature will drop approximately 0.4-0.7°C every 100 meters (Bawaihaty, 2014). The altitude of the place also affects the surrounding microclimate range. The altitude and the temperature affects the growth of moss species. In general, most moss likes a wet and moist place, both in lowlands or in highlands (Puniman, 2005).

Average air humidity measured in sampling location as presented in Table 4 showed 81.4% humidity in the morning, 80.43% at noon and 91% in the afternoon. According to Glime (2009), the ideal average humidity for moss growth is about 77-80% while the moss can survive in relative humidity ranges from 23-100%. So the location of Kapas Biru Waterfall is compatible location for overgrown moss vegetation.

The average range of light intensity as shown in Tabel 4 stated 4195.33 lux in morning, 13234.13 lux at noon, and 1398.33 lux in the afternoon. The intensity of light in an ecosystem is varied. The canopy of a vegetation will hold and absorb some of the light so it will determine the amount of light penetrated and represent the amount of energy that moss plants can exploit. According to Kramer & Kozlowski in Widiastuti (2004), the level of shade influences the intensity of incoming light in floor vegetation such as moss. The shade plants that has a wide canopy and high stem will reduce the intensity of incoming light. The greater the shade level the smaller the intensity of light, so the air temperature becomes lower, and the air humidity becomes higher.

Air humidity have a significant affect on growth because it directly relate to the process of photosynthesis. The rate of photosynthesis increases with the increase of air humidity around the environment or microclimate. From the statement it shows that the intensity of light affects the growth of moss. If the growth of moss decreases it will also decrease the abundance of moss, and vice versa.

Moss vegetation is also affected by wind speed. Based on Table 4 the average wind speed range from 32.8 m/s to 176.67 m/s, with the peak happened at noon. Wind is very influential on the spread of spores moss and spore seedlings that can determine the growth and presence of moss vegetation. The growth of spores falling on the ground is also supported by soil conditions, one of which is soil moisture and soil pH. The mean yields of the soil pH range between 6.2 to 6.7. While the average yield of soil moisture range is 47.53% up to 55.93%.

Soil pH influences the absorption of soil nutrients by plants. If the soil pH is too acidic, the nutrients will not be absorbed maximally. According to Mustofa (2005), good soil is a

soil that has the ability to store water and nutrients and also supported by soil pH of 6.1 - 6.7, which means the acid is close to neutral. pH 6.1 - 6.7 is a good pH for most of plants including moss.

Biotik factors that affect the growth of moss is shade tree. Kapas Biru Waterfall has high shade tree types and has a wide canopy. Common shade tree species are Bendo, Weringin, Flowerwood, Sengon algasia, Bamboo, Cloves, Durian, Petai, Kelengkeng, Waru gunung, Mahoni. In addition there are also lush coffee plants are on the edge of the cliff and along the path. Moss growth is highly dependent on humid conditions, one of them in a position under the shade of the tree. It also found frequently attached to the tree trunk as epiphyte. This shaded condition can increase the surrounding humidity so it can be overgrown with moss.

Moss has its own uniqueness and character. The uniqueness and distinction of these characters are considered as species diversity. Such diversity is assumed as evolutionary impact within the moss group it self. The diversity is seen in terms of morphology. Morphology is the structure or outer shape or body shape of the moss itself. The morphology of moss is seen in terms of size. Moss size tends not to be large or grow tall. This is because the physiological structure of the moss is lower than the higher plants or seed plants. According to Glime (2013), the moss grows with a certain size limit that becomes the character that the moss has no lignin. This makes the moss has different shapes and sizes that become character and uniqueness in the level of diversity of moss plants.

True moss has distinct characters that differs from hornworts and liverworts. Hornworts and Liverworts have similar in structures of their gametophyte thallus, on the contrary gametophyt thallus of true moss can be distinguished from part to part. It has leaf, stem and root structures in the form of rhizoid. According to Suhono (2010), In general, true moss's division is divided into 8 large classes. Among those 8 classes, 13 species were found through identification conducted in this study. They are *Herpetineuron toccae, Philonotis gracillima, Barbella horridula, Barbella flagillifera, Grimmia elongata, Ectropothecium* sp. *Hyophila javanica, Ectropothecium ichnotoclaadum, Bryum argentum, Thuidium* sp., *Weissia edentula, Racopilum spectabile*, and *Fissidens* sp. The true moss found belonging to the class of Bryopsida are presented in Figure 1.

Figure 1 (A). *Philonotis gracillima*, (B). *Barbella horridula*, (C). *Grimmia elongata*, (D). *Ectropothecium* sp, (E). *Fissiden* sp.

The structure and morphology of the species found especially Herpetineuron toccae, Philonotis gracillima, Grimmia elongata, Hyophila javanica, Bryum argentum, and Weissia edentula have something in common. It is seen in the growth of the talus, each individual having needle-like leaf that surrounds the stem. On the contrary, *Barbella horridula, Barbella flagillifera, Ectropothecium* sp., *Ectropothecium ichnotoclaadum, Thuidium* sp., and *Racopilum spectabile* have somewhat flattened thallus and repens growth pattern. The most unique structure of the species found is Fissidens sp. Moss of this type has a unique character that resembles the structure of goose feathers. The genus group of Fissidens has a similar morphology and has stem that ducks until almost invisible.

The most dominant true moss found is *Grimmia elongata* Kaulf. in J.Strum. It was found in two different sampling locations, along the footpath and around the waterfall. On the trail to the location as well as around the location of waterfall, this species was found at some points of the cliff edge and the surface of the soil spilled by water splash. The cliffs located in close proximity to the flow of water, so when the sample was taken it was drenched, although not submerged in water. Grimmia elongata Kaulf. in J.Strum. is not classified as aquatic moss. According to Greven & Sotiaux (2003), *Grimmia elongata* Kaulf. in J.Strum. found around the Austrian mountains grows abundantly on the edge of hills where the temperature is relatively cold. In Belgium, Grimmia thrives in 400 m altitude and more.

Many types of mosses or similar plants can contribute significantly to the floral biodiversity in the Kapas Biru Waterfall. Moss

that grows or found can be special or endemic, they only grow on specific location.

The speficic species is compatible species that can grow and thrive in locations with the environmental characteristics of kapas Biru Waterfall. So that the biodiversity moss in that particular area becomes characteristic mark or uniqueness that is not owned by other places. The sustainability can be balanced by the conservation, identification, and inventory of biodiversity in the location.

4. CONCLUSION

Based on the results and discussion of this research, it can be concluded that as much as 13 species of true moss belonging to the division of Bryophyta found in the Kapas Biru Waterfall Pronojiwo Lumajang. The most dominant species found in the area of the path and the area around the waterfall is *Grimmia elongata* Kaulf. in J. Strum

5. REFERENCE

Bawaihaty, Nuroh, et al. 2014. Keanekaragaman dan Peran Ekologi *Bryophyta* di Hutan Sesaot Lombok, Nusa Tenggara Barat. Jurnal Silvikultur Tropika. Vol. 05 N0. 1 April 2014 Hal 13-17.

Dinas Pariwisata Kab.Lumajang. 2015. *Letak Geografis Air Terjun Kapas Biru Kecamatan Pronojiwo*.

Glime, Janice. M. 2009. *Bryophyta Ecology Volume 1 Physiological Ecology*. Ebook sponsored by Mechigan Technological University and the International Association of Bryologist.

Glime, Janice. M. 2013. *Bryophyta Ecology Volume 1 Physiological Ecology*. Ebook sponsored by Mechigan Technological University and the International Association of Bryologist.

Greven, H.C. & A. Sotiaux. 2003. The boreal-alpine Grimmia elongata Kaulf., still present at Willerzie (Belgium) after 132 years. Belg. Journ. Bot. 136: 165-166.Lalhriatpuia and Laha, Ramachandra. 2015. Bryophyte Diversity In Mamit District, Mizoram, Northeast India. *Int J Pharm Bio Sci* 2015 Oct; 6(4): (B) 1204 – 1209.

LIPI. 2015. from lipi.go.id Diakses tanggal 11 Desember 2016.

Menih. 2006. *Pembangunan Taman Lumut dan Kebun Raya*.

Mustofa, A., 2007. Perubahan Sifat Fisik, Kimia, dan Biologi Tanah Pada Hutan Alam yang Diubah Menjadi Lahan Pertanian di Kawasan Taman Nasional Gunung Leuser. [Skripsi]. Fakultas Kehutanan. Institut Pertanian Bogor, BogorPuniman, F.X. 2005. *Taman Lumut Cibodas, Satu-satunya di Dunia*.

RPJMD. 2015. Rencana Pembangunan Jangka Menengah Daerah Kabupaten Lumajang 2015-2019 from lumajangkab.go.id/ rpjmd2015.php.

Steenis, C.G.G.J.van. 2010. *The Mountain Flora of Java: Edisi Indonesia*. Jakarta: LIPI Press Sungkar, R. 2006. *Taman Lumut Kebun Raya Cibodas*.

Widiastuti, Libria, Tohari, Sulistiyaningsih, Endang. 2004. Pengaruh Intensitas Chaya Dan Kadar Daminosida Terhadap Iklim Mikro Dan Pertumbuhan Tanaman Krisan Dalam Pot. *Ilmu Pertanian* Vol. 11 No.2, 2004: 35-42.