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Diversity of *Bryophyte* in the Selarong Cave Area, Bantul, Yogyakarta

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Abstract

The Selarong Cave area which is located in Bantul is a tourism site that has a humid environment condition due to the dense of big trees in these locations. There is also a waterfall. These conditions make it possible for bryophyte to grow surrounding the area. This research aims to identify the type of bryophyte grow in the Selarong Cave area, and know the characteristics. The method of this research is the exploration method which includes site investigation, identification, inventory, and descriptive analysis for both morphology and anatomy of the bryophyte. The finding of this research shows that there are 6 species of bryophyte which were found in the Selarong Cave area. They are Hyophila involuta (Hook.) Jaeg., Barbula consanguinea (Thw.&Mitt.) Jaeg., Bryum erytropus Fleisch., Weissia controversa Hedw., Preissia sp., and Vesicularia dubyana (C. Mull.) Broth.

1. INTRODUCTION

Moss plant (Bryophyte) is a very simple plant that belongs to low-level plant groups because the body is still in the form of talus which does not have a carrier file. This plant looks very simple even it is often considered as environmental causes such as a wall, floor, park, tree, and dirty rocks. When this plant is being observed, it is actually interesting, in terms of color, shape, and life which appear in groups. Some of them form a cushion like a carpet. The uniqueness of this plant in terms of morphology and anatomy is so interesting to be studied.

Knowing the diversity of Bryophyte and the uniqueness of its structure, some researchers had conducted research on the diversity of Bryophyte including Sulistyowati (2014), regarding the Diversity of the Marchantiophyta Epiphytic Montana Zone in Ungaran Mountain Area, Semarang Regency, Central Java, Indonesia; Windadri (2007), regarding moss (Musci) in the Kekenauwe Nature Reserve and Lambusango Wildlife Reserve, Buton Island, Southeast Sulawesi, Indonesia; Samti et al (2016), Potential of Bryopsida in R Soerjo Forest as a Supplement in the college course of Plant Diversity; Wati et al (2016), regarding Biodiversity of Bryophyte in the Forest Around Kedung Brubus Reservoir, Keceng sub-district, Madiun Regency, East Java, Indonesia. For Yogyakarta region, research about Bryophyte or moss plant had been carried out in the post-eruption Merapi area (Suharti, 2013) and in Turgo (Mubarokah, 2015). Research of the identification of Bryophyte that grows in many historical sites such as cave has not been widely carried out. Somehow, based on the result of preliminary observation which has been carried out, it turns out that Bryophyte can be grown in the cave area. One of the tourist sites that has historical and educational value is Selarong Cave which is famous for the history of Prince Diponegoro.

Geographically, Selarong Cave is located in Kembang Putihan hamlet, Guwosari Village, Pajangan sub-district, Bantul, Yogyakarta, Indonesia. It is located in the south of Yogyakarta City, about 30 km from the city center. The location of Selarong Cave is close to a waterfall, and around the complex of the cave, there are trees and river. Thus, the complex around Selarong Cave has several places that is grown by Bryophyte, but in the complex of Selarong Cave, there is no research data about the species of Bryophyte.

2. RESEARCH METHODS

This research is a research of exploration which includes roaming, inventory, identification, and characterization of Bryophyte. The preparation was using leaf clearing and whole mount method, and the observation was using optilab. The identification was carried out at the Laboratory of Plant Taxonomy Laboratory, Faculty of Biology, Universitas Gajah Mada.

3. RESULTS AND DISCUSSION

During the research, the condition of the environment supported for the life of Bryophyte in the Selarong cave area. The air humidity in the Selarong cave area reached 95% with the location that is grown by shady trees with a waterfall on the right side of the cave. It makes the area feel comfortable. Then, the light intensity which was obtained was 23.9 Lux, with the maximum air temperature during the day was reaching 30ºC and also the soil PH measurement of 5.6. Moss requires a humid environment, low light intensity, a temperature that is not too hot, acidic PH almost neutral. The following is the *Bryophyte* which was found in Selarong cave:

Table 1. Observation Data of Bryophyte Identification in the Selarong Cave Area, Bantul, Yogyakarta, Indonesia.

No	Species	Family
1	*Hyophila involuta* (Hook.) Jaeg.	Pottiaceae
2	*Barbula consanguinea* (Thw. & Mitt.) Jaeg.	Pottiaceae
3	*Bryum erytropus* Fleisch.	Bryaceae
4	*Weissia contoversa* Hedw.	Pottiaceae
5	*Preissia sp*.	Marchantiaceae
6	*Vesicularia dubyana* (C. Mull.) Broth.	Pottiaceae

Based on Table 1. *Pottiaceae* family was mostly found in the Selarong Cave area. This family can grow in various conditions. The members of the *Pottiaceae* family mostly have erect and stiff *phylloid* which are thought to adapt in the environment with a dry condition. Bryaceae family in the Selarong Cave area was found in one type of *Bryophyte*, namely *Bryum erytropus Fleisch*. Both families belong to the group of *moss*.

Then, Marchantiaceae family was found in one type of *Bryophyte*, namely *Preissia sp*. This family is usually thick and grows tightly together. The color is dark green, light green, and also blackish green. This *preissia* mostly lives in wet or humid soils and it belongs to terrestrial plant. This *Bryophyte* is classified as a liverwort.

The majority of *Bryophyte* is green because they have cells with plastids containing chlorophyll a and chlorophyll b. The vegetative structure of *Bryophyte* consists of talus and *rhizoid*. Talus primitive *Bryophyte* is slithering, whereas in new *Bryophyte*, the talus resembles a high-level plant which consists of the stem (*cauloid*) and leaves (*phylloid*) (Glime, 2007).

It can be known that the six types of *bryophyte* have differences and similarities morphologically. The differences are in terms of the color of the *phylloid* or the color of the talus, the shape of the *phylloid*, the tip of the *phylloid*, the base of the *phylloid*, the shape of the cell, the existence of midrib, if there is a midrib, the shape of midrib cell is also typical, and the edge of the *phylloid*. *Moss* and liverworts which were found in the Selarong Cave area grew attached to various substrates. There were 4 types of *bryophyte* which were found on substrate rocks. They were *Hyophila involuta* (Hook.) Jaeg., *Consanguinea Barbules* (Thw. & Mitt.) Jaeg. *Bryum erytropus Fleisch*., And *Weissia contoversa Hedw*. Then, the *bryophyte* which was found on the soil substrate namely *Preissia sp*., And the *bryophyte* which was found on tree substrate was *Vesicularia dubyana* (C. Mull.) Broth.

The research which was conducted at Selarong Cave, Bantul, Yogyakarta, Indonesia found six species of bryophyte from two classes. They were *moss* (*Bryopsida*) and liverwort (Hepatycopsida). There were 5 types of *moss* (*Bryopsida*) which were found including *Hyophila involuta* (Hook.) Jaeg .; Consanguinea barbell (Thw. & Mitt.) Jaeg .; *Bryum erytropus Fleisch* .; Weissa contoversa Hedw .; *Vesicularia dubyana* (C. Mull.) Broth; then from the liverwort (Hepatycopsida), there was found one type, namely *Preissia sp*. (table 1).

The difference in the number of species has a relationship with the environmental condition of the research location. The environmental condition includes abiotic and biotic factors. A biotic factor is a living part of an environment, while the abiotic factor is all non-life parts of an ecosystem. The examples of the abiotic factor are temperature, light, sun, oxygen, water, soil, and stone. Both abiotic and biotic factors have an important role in the growth and distribution of *bryophyte* in an ecosystem.

The Selarong Cave area has several areas which were used as places for sampling *bryophyte*, including the children are at the first stair, the children area at the second stair, the playground at the third stair, and the top area below the cave. The description of *bryophyte* found in the Selarong cave area of Yogyakarta, Indonesia:

a. Hyophila involuta (Hook.) Jaeg.

Hyophila involuta (Hook.) Jaeg. gametophyte in the form of the talus, light green color, acrocarpous, living sticks to the rocks. It has a *phylloid* tongue with an acutus tip (pointed), an integer edge (flat), in the middle of the *phylloid* there is *costa* percurrent (reinforcement ends on the

tip of the leaf), with the length of *phylloid* is 2,130.49 ± 63.82µm, and the width is 724.36 ± 41.37 µm. Based on the observation of cell structure, the Hyophila involute *phylloid* (Hook.) Jaeg. has a cell in the middle of the strand (a cell that makes up a *costa*). It is a rectangle with the length of 28.84 ± 7.08µm, and the width of 5.57 ± 0.64µm, while the cell at the edge of the leaf strand has a rectangular shape with the length of 23.68 ± 0.86µm, and the width of 7.35 ± 0.32 µm. *Hyophila involuta* (Hook.) Jaeg. is a tufted *bryophyte* with 1.5 cm high, and has a strong brownish or reddish *costa*. The color of the soft *seta* is brownish red, with a length of 1.5 cm, and there is a cylindrical capsule.

Hyophila involuta (Hook.) Jaeg. was found in the first stair area, second stair area, playground, and the top area below the cave. This *bryophyte* is mostly found sticking to rocks, and it is often found in the Selarong Cave area.

***b. Barbula consanguinea* (Thw. & Mitt.) Jaeg**

Barbula consanguinea (Thw. & Mitt.) Jaeg. has green talus, acrocarpous, living sticks to the ground by using *rhizoid*. It has a part which looks like a stem that has a tightly arranged *phylloid* and will become a bit curly when it is dry. It has a lanceolate *phylloid* with an *obtusus* tip (blunt), an integer edge (flat), and in the middle of the *phylloid* there is a *costa* percurrent (reinforcement ends at the tip of the leaf), with a length of the *phylloid* is 1728.19 ± 25.45µm and the width is 678.99 ± 34.14µm. Based on the observation of cell structure, *Barbula consanguinea phylloid* (Thw. & Mitt.) Jaeg has a cell in the middle of the strand (a cell that makes up a *costa*). It is a rectangle with the length of 32.86 ± 3.98µm, and the width of 5.78 ± 0.50µm, while the cell at the edge of the leaf strand has a rectangular shape with the length of 16.02 ± 2.72µm, and the width of 7.52 ± 1.04 µm.

When carrying out the research, the *bryophyte* had not experienced a sporophyte phase yet. Thus, there was no spore capsule found. This *bryophyte* was found on moist or wet soil after rain.

Barbula consanguinea (Thw. & Mitt.) Jaeg. which was found in the Selarong Cave area, was mostly found sticking to rocks. This type of *bryophyte* was found in the first stair area, second stair area, and the playground.

c. Bryum erytropus Fleisch.

Moss is also called the real *bryophyte*. It is a small plant that the part of the body is like a root (*rhizoid*), stem and leaf. Its vegetative reproduction is by forming bud on the branches of the stem. The bud will form a new *moss*. *Moss* is mostly found in moist places. Its structure is like a root which is called as *rhizoid* and also like a leaf. *Bryopsida* is the largest class of *moss* and has the highest level of development, because both the gametophyte and sporophyte already have more complex parts. *Sporogonium* of *moss* consists of leg, *seta*, and capsule. The capsule has many parts which are called as apophyse, a spore box or theca, and cover or operculum.

The sporophyte is generally smaller, short-lived, and life is depending on gametophytes. The structure of the body is similar to stem, leaf, and root, but it does not have a carrier file as in high-level plants.

Bryum erytropus Fleisch has a lanceolate *phylloid* with an *acuminatus* tip (tapered), and an integer edge (flat). In the middle of the *phylloid*, there is a *costa* percurrent (reinforcement ends at the tip of the leaf), with a length of the *phylloid* is 1588.705µm ± 9.62µm, and the width is 261.046µm ± 9.04µm. Based on the observation on cell structure, *Bryum erytropus Fleisch Phylloid* has a cell in the middle of the strand (a cell that makes up a *costa*). It is a rectangle with a pointed tip with the length of 69.45 ± 4.83µm, the width of 10.27 ± 1.27µm, while the cell at the edge of the leaf strand is a rectangle with the pointed tip and the length of 81.02 ± 14.47µm, and the width of 20.61 ± 3.561µm. In this research, *Bryum erytropus Fleisch* was found in the first stair area and second stair area, and the substrate was rock.

d. Weissia contoversa Hedw.

Weissia contoversa Hedw has a hairlike *phylloid*, with the tip type of the *phylloid* is acutus. The cell is a rectangle and it has a rectangular midrib. The color of the *phylloid* is green with a length of the *phylloid* is about 2896.04 ± 27.09 µm, and the width is 382.79 ± 57.09µm. *Weissia contoversa Hedw* has a *phylloid* cell which the length is about 23.84 µm, and the width is about 8.48 µm. This *bryophyte* also has a midrib which the length is about 43.82 µm and the width is 9.20 µm.

Weissia contoversa Hedw was found in an area which is close to Lanang Cave and Putri Cave. This *bryophyte* sticks to the rock and lives in groups. It lives cumulatively one another and forms like a cushion. This *bryophyte* was dominantly found in the area close to Lanang Cave and Wadon Cave.

e. Preissia sp.

Preissia sp. is a liverwort which the habitat is in a humid place, sticking to soil or rocks. The talus is like a ribbon, rather thick, branched, scratched and has a middle rib that is not too prominent. The bottom side has a ventral scale and *rhizoid*. The vegetative reproduction uses gemma cup and the generative one uses Spore. Its body is divided into two lobes, that is why it looks like a lobe in the liver. Inside the sporangia, there is a rolling cell which is called elatera. Elatera will be released when the capsule is opened. Thus, it helps to spread the spore. This *bryophyte* can also do asexual reproduction with a cell which is called gemma. The

structure is like a bowl on the surface of the gametophyte.

Preissia sp. in the Selarong Cave area was only found in the first stair area. This *bryophyte* is a liverwort which was found sticking to rocks. It lived in groups with its kind. *Preissia sp*. has the green talus which the shape is like a heart. It has a talus *frondose* (sheet) with a *retusus* tip (split), *repandus* edge (wavy), with the length of 5900 ± 1349.89 µm, the width of 3600 ± 809.66 µm, and there was no *costa* percurrent. Based on the observation of the cell, the *phylloid* of *Preissia sp*. had a hexagonal cell with a length of 43.94 ± 4.39µm, a width of 24.23 ± 2.61 µm. Liverwort attaches to the substrate with unicellular *rhizoid*. It has a dichotomous talus that has branches and generally, it consists of several thick cells. The upper tissue (dorsal) is loose, which is resulted from internal air space and generally, it has pores. The lower surface (stomach) usually has two types of *rhizoid*. They are smooth and has bumps. It usually also has scales (Glime, 2006 in Sulistyowati *et. al*, 2014).

The Hepaticopsida class has characteristics that distinguish it from other classes. It is because of the oil bodies. Oil bodies are terpenoid oil storage organelles that have a function to prevent herbivores and protect cells from low temperature and also UV light (Goffinet & Vanderpoorten, 2009).

***f. Vesicularia dubyana* (C. Mull.) Broth.**

Vesicularia dubyana (C. Mull.) Broth. in the Selarong Cave area was found sticking to trees (wood) which was in the playground of Selarong Cave area. This *bryophyte* is a *moss* which is found in groups of the same type. *Vesicularia dubyana* (C. Mull.) Broth. has green *phylloid*, the shape of the *phylloid* is ovate, the edge is acutus, the tip is *acuminatus*. This *moss* has the length of the *phylloid* about 2483.04 ± 8.77 µm, and the width about 1077.95 ± 18.18 µm. *Vesicularia dubyana* (C. Mull.) Broth. has an oval cell with the length of it about 42.59 µm, and the width of 4.97 µm.

g. The determination key of bryophyte that was found in the Selarong Cave Area

Based on the morphologically and anatomically observation of bryophyte in the Selarong Cave area, Bantul, Yogyakarta, Indonesia, the determination key can be made as follows:

1. a. Stone substrate 2
   b. Land substrate …… *Preissia sp*.
2. a. Green *phylloid* 3
   b. light green *phylloid* ……... *Hyophila involuta* (Hook.) Jaeg.
3. a. The morphological form of lance *phylloid* 4
   b. The morphological form of Hairlike piloid …… *Weissia contoversa* Hedw.
4. a. Tip type of *phylloid acuminatus* 5
   b. Tip type of *phylloid* acutus ……..… *Consanguinea Barbells* (Thw. & Mitt.) Jaeg.
5. a. The average length of the *phylloid* was 1041.79 ± 1104.23 µm ……..……. *Bryum erytropus* Fleisch.
   b. The average length of the *phylloid* was 2122.13 ± 2173.21 µm …… *Vesicularia dubyana* (C.Mull) Broth

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the finding of the research "Diversity of Bryophyte in the Selarong Cave Area, Bantul Regency, Yogyakarta", it can be concluded as follows. In the Selarong Cave area, there are 6 different types of bryophyte which are *Hyophila involuta* (Hook.) Jaeg., *Barbula consanguinea* (Thw.&Mitt.) Jaeg., *Bryum erytropus* Fleisch., *Weissia controversa* Hedw., *Preissia* sp., and *Vesicularia dubyana* (C. Mull.) Broth. The most common bryophyte was found on the wall of Selarong cave. It was *Weissia controversa* Hedw. It has the characteristic of a hair like phylloid, and the tip is acutus and the shape of the cell is a rectangle.

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