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Inventory of Epiphytic Moss in the Tree Trunk Zonation of Jumog Waterfall Ngargoyoso Tawangmangu Karanganyar Central Java, Indonesia

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ABSTRACT

The concept of epiphytic plants is a critical plant that determines the processes occurs in ecosystems. Epiphytic plants especially Bryophytes or commonly moss is one of primary epiphytic productivity. This study aims to record any epiphytic moss in their natural habitat at the Jumog Waterfall Forest Ngargoyoso in Karanganyar Tawangmangu Central Java. The method used in this study was purposive sampling, this method using exploration techniques. Field data observed were epiphytic plants from the Bryophyte groups (moss plants). The results showed that there were five moss colonies namely *Bryum billardieri*, *Octoblepharum albidum*, *Leucobryum aduncum*, *Heteroscyphus coalitus* and *Pogonatum neesii*, in 3 different zones I, II, III of phorophytes.

Keywords: epiphytes; Jumog Waterfall; moss; phorophytes

INTRODUCTION

Epiphyte plants are popular in tropical areas as terrestrial plants, apparently stick to the higher plants (Sales *et al.*, 2016) generally on the surface of the tree trunk (Hongsanan *et al*., 2016), and understory (Sales *et al.*, 2016). They grow on other plants called host plants (Zhao *et al*., 2015; Malizia, 2003).

Distribution of basal parts of the trunk include zone I (0-3 m), zone II (3-5 m from the upper ground and 3 m up), zone III is basal large branches (1/3 of the total length branch), zone IV is the middle part of tree large branches (1/3 of the total length of branches) and zone V is the outer of the large branches (Figure 1) (Johansson, 1974). Tree trunk as a host of epiphytes called phorophytes. In the natural ecosystem, there are many sizes of trees, zonation is a simple way to invent the distribution of epiphytes in a phorophyte (Johansson, 1974; Norman *et al*., 2010).

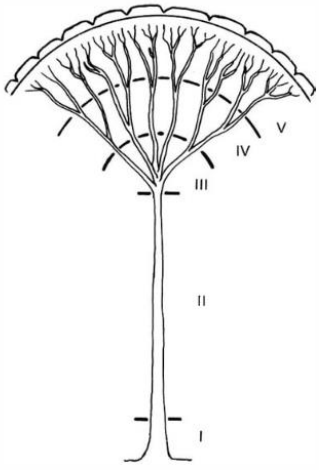

Figure 1. Zones of epiphytes distribution on tree trunk include of zone I, II, III, IV, and V

Jumog Waterfall is one of the waterfall tourist areas in the Berjo village, Ngargoyoso Tawangmangu Karanganyar of Central Java. Jumog waterfall is a tropical ecosystem in

Central Java, Indonesia, the coordinates 7°37'52.68" S and 111°7'37.24" E, 992-1095 masl. The daily temperature is 24.8-30.6°C and moisture is about 66-82% (Roziaty *et al*., 2016).

Bryophytes, in general, is a part of Angiosperm, embryophytes, green plants hence contain chlorophylls in their thallus. Mosses (Musci), liverworts (Hepaticaea) and hornworts (Anthocerotopsida) are three division of Bryophytes (Pruchner *et al*., 2002; Shaw and Renzaglia., 2004). Mosses are common plants in Jumog Waterfall (Rohmah *et al*., 2018).

The epiphytes especially mosses do not take nutrients from their hosts. Their nutrient and water come from their environment (Cardelus & Macks, 2010). The epiphytes actually can arrange their water consumption from the environment (Stanton *et al*., 2014). The mosses have a wide range distribution in the tropical area with a variety of habitats ranging from soil, sand, rocks, tree trunks, the litter of tree trunk in the forest to waters. Environmental factors that influence the growth of moss are humidity, temperature, and light intensity. Differences in tolerance among the species of moss to environmental factors will affect the level of adaptation, species composition, and distribution of mosses (Bačkor *et al*., 2009; Proctor, 2000; Lovelock & Robinson, 2002; Wood, 2007). This study aims to invent the epiphytes moss in the various zone of the tree trunk in their natural habitat in Jumog Waterfall Ngargoyoso Karanganyar Central Java.

MATERIALS AND METHODS

This research was conducted in the tourist area of Jumog Waterfall Forest and its surroundings as in Figure 1.

Determination of sampling points. The method of the research was an explorative method using a purposive sampling technique. The study was conducted into two stages: 1) The first stage was determining the research site with the exploration of the area by tracking notice the mosses existing. Here was the sample station divided into two different locations according to the level of topography, around 1.000 masl. In each station, 10 trees were chosen as sub-station (Figure 1). 2) The second stage was identifying and taking mosses in the location. The sample brought to the Laboratory of Department of Biology Education, Universitas Muhammadiyah to determine the species. The abiotic factors noted such as environmental temperature and moisture.

Figure 2. Location of sampling in the forest area of Jumog Waterfall Ngargoyoso Karanganyar, Central Java (Each station is indicated by a red dot)

The object observed was moss found in the Jumog Waterfall Ngargoyoso Tawangmangu Karanganyar, Central Java. Identifying the mosses was using Plants in Tropical Cities (Min *et* al., 2014) (Kelly, 2006), and Flora (van Stennis, 1992).

Data analysis. Subsequent data are data regarding the distribution of epiphytic mosses in their phorophytes (Zone I, II, III, IV, and V).

RESULT AND DISCUSSION

Identification of epiphytic vegetation. Based on the results of research conducted on mosses plants, epiphytes generally stick to the *Pinus merkusii*. Pine trees are one of the tree species dominant in the Jumog Waterfall Ngargoyoso Tawangmangu Karanganyar, Central Java (Table 1).

Table 1. The Moss on their phorophytes in Jumog Waterfall Ngargoyoso Tawangmangu Karanganyar, Central Java

No.	Species	Phorophytes	Zonation on phorophytes
1	*Bryum billardieri*	*Pinus merkusii*	I, II and III
2	*Octoblepharum albidum*	*Pinus merkusii*	I, II
3	*Leucobryum aduncum*	*Pinus merkusii*	I, II
4	*Heteroscyphus coalitus*	*Pinus merkusii*	I, II
5	*Pogonatum neesii*	*Pinus merkusii*	I, II and III

Bryum billardieri and *Pogonatum neesii* were found in zone I, II and III in Jumog Waterfall Ngargoyoso Tawangmangu Karanganyar, Central Java, while *Octoblepharum albidum*, *Leucobryum aduncum* and *Heteroscyphus coalitus* found in zone I and II in their phorophytes. Genus Pogonatum used to be found in mountain plants, widely distributed in the tropical area until Europe (Hassel *et al*., 2005; Hassel *et al*., 2005). Genus Leucobryum can live in a drought place. It is a high tolerance genus in the mosses group (Chiarucci A *et al*., 2008; Vitt *et al*., 2014; Katalin *et al*., 2017).

Bryum billardieri has morphological characteristics, the thallus that stands tall or creeps on the ground, trees, and rocks. Leaves are lanceolate or oval with tapered leaf tips. The location of the leaves encircles the thallus (rosette) with a shiny leaf surface (Figure 3).

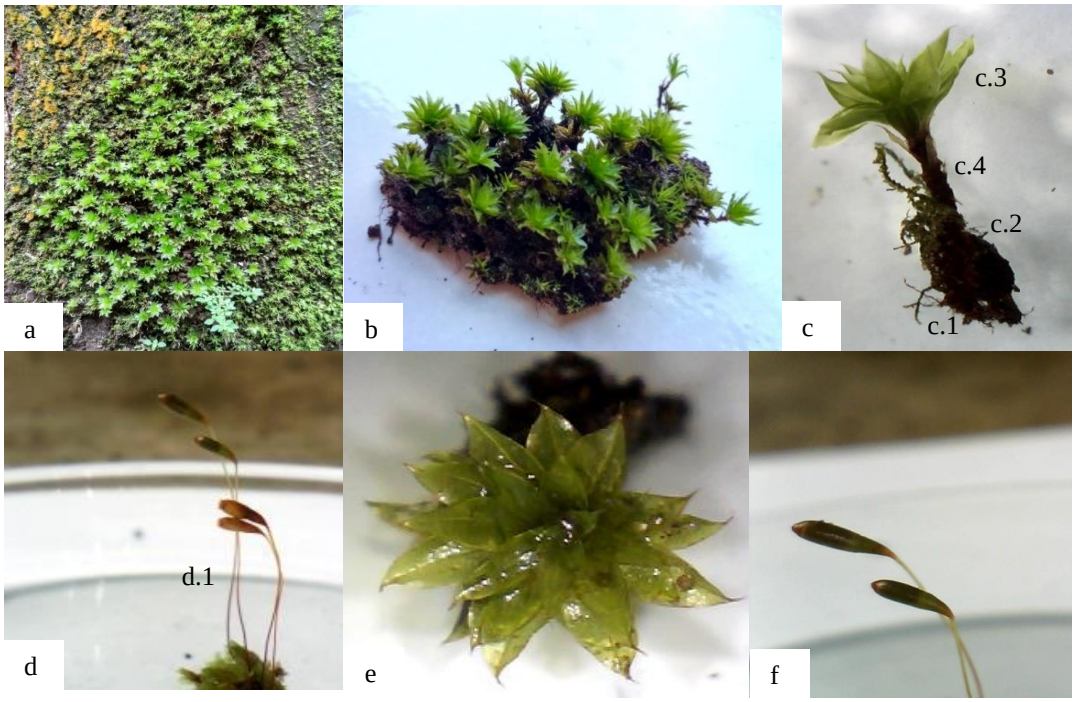

Figure 3. Morphology of *Bryum billardieri*: a. Macroscopic *Bryum billardieri*; b. Colonies of *Bryum billardieri*; c. Structure of the thallus *Bryum billardieri*: c.1. rhizoid; c.2. stolon; c.3. gametophyte; c.4. stem; d. sporophyte: d.1. seta; e. Gametophytes are seen from above; f. sporangium

Pogonatum is one of the species of the family Polytrichaceae. It has small to medium body morphological characteristics, with a height of 5-50 mm, elongated and loose. Narrow-leaf, tapered leaf tip, flat-leaf edge, and louse. The shiny leaf surface is green to brown. Often encountered and widely distributed throughout the region from moderate to high altitudes. Grows to form colonies that are scattered in an open, sheltered, dry or humid

place. The phorophytes are pine (*Pinus merkusii*) in zone I, II and III (Figure 5).

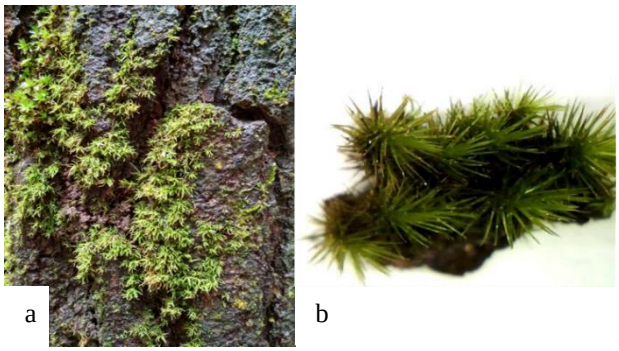

Figure 4. Colonies of *Pogonatum cirratum*: a. in their phorophytes *Pinus merkusii*; b. Thallus of Pogonatum

The phorophytes are pine (*Pinus merkusii*) in zone I, II and III from the upper ground. The mosses grew attached to the tree bark starting from the basal area upper ground until the base of large branches of trees near the tree crown due to the better sunlight (Nurfadilah, 2015).

Octoblepharum albidum is a species from classis Bryopsida with a morphological structure usually less than 2 cm, a thick leaf texture, and light green to whitish. Sporophytes in *Octoblepharum albidum* can be seen clearly. In the sporangium, there is a capsule, stalk, and seta. Seta lifts the capsule up, thus the spores released are easily blown off by the wind and scattered everywhere. The top of sporangium is a creature or also called a spore box covering organs (Figure 5).

Octoblepharum albidum grows in colonies attached to the bark of pine trees (*Pinus merkusii*) in zone I, and II, with a rhizoid intermediate as an adhesive tool on the substrate. Habitat of dry forest in humid made *Octoblepharum albidum* easily grow abundantly (Maciel-Silva *et al*., 2013), therefore Jumog Waterfall forest is a suitable habitat for *Octoblepharum albidum*.

Figure 5. The stature of a. *Octoblepharum albidum*, b. Sporophyte *Octoblepharum albidum*: b.1. Calyptra, b.2. Sporangium, b.3. Seta; c. Gametophyte with sporophytes on top of it, d. Colonies of *Octoblepharum albidum*

Environmental conditions. Data obtained from measurements of abiotic factors at the study site in Jumog Ngargoyoso Karanganyar Waterfall Central Java (Table 2) include ambient temperature, air humidity, soil pH, soil moisture and location altitude (masl). Under these environmental conditions, mosses can grow and develop properly.

Table 2. Results of measurements of environmental conditions in the Jumog Ngargoyoso Waterfall Area in Karanganyar, Central Java

No	Abiotic factors	Range
1	Environmental temperature (ºC)	25 – 26
2	Humidity (%)	70 – 74
3	Soil moisture (%)	55 – 65
4	Topography (masl)	900 – 1085

Temperatures of 25-26°C and humidity of 70-74% produce differences in the type and number of mosses found in locations with topography 900-1085 masl. This temperature makes the environment moist and humid, as a favorable habitat for mosses. Environmental factors greatly affect the growth of moss ranging from air temperature, humidity, rainfall, land height, pH and light. The availability of groundwater affects the growth of epiphytes, especially moss that is usually associated with lichen. Microclimate affects the distribution of moss in their natural habitat (Barve *et al*., 2014).

CONCLUSION

The results showed that there were five epiphytic colonies from the Bryophyte group, namely *Bryum billardieri*, *Octoblepharum albidum*, *Leucobryum aduncum*, *Heteroscyphus coalitus* and *Pogonatum neesii*, in 3 different zones of phorophytes: zone I, II and III.

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