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Bryophyte Diversity in Sawit Hiking Trails of Mount Andong, Magelang Regency

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Abstract. This research aims were to determine the types of bryophyte plants in Sawit Hiking Trails of Mount Andong, Magelang Regency. This diversity study resulted in 28 genera from 21 bryophyte plant families. The Pottiaceae and Brachytheciaceae families were the ones with the highest number of genera, namely 3 genera; Polytrichaceae, Dicranaceae, and Bryaceae consist of 2 genera; and other families only 1 genera. The most common bryophyte are Bryophyta were previously known as mosses.

Keyword: *Marchantiophyta*, *Bryophyta*, *Anthocerotophyta*, Mount Andong

Running Title : Bryophyte Diversity in Mount Andong

INTRODUCTION

Indonesia is a tropical country that has quite high rainfall and gets sunlight every year. The condition causes Indonesia to have considerable biodiversity, both in flora and fauna diversity. One of the diversity of flora is the diversity of bryophyte that belong to low-level plant groups. According to Gradstein (2001) in Windadri (2017) there are approximately 15,000-25,000 bryophyte species in the world, of which approximately 1500 species are grown in Indonesia (Nuroh et al. 2014).

Bryophyte diversity is quite high but under-noticed and considered not endangered due to its abundant presence. With forest deforestation, forest fires, and natural disasters such as volcanic eruptions, bryophyte is also one of the endangered biodiversity. Some types of bryophyte have been included in the International Union for Conservation of Nature (IUCN) list with vulnerable or vurnerable (VU) status and critically or critically endangered (CR). The types of bryophyte susceptible are *Dendroceros japonicus* (Anthocerotaceae), *Sphagnum novo-caledoniae* (Sphagnaceae), *Nardia huerlimonnii* (Jungermanniaceae), and *Personiella vitreocincta* (Personiellaceae). The critically-reviewed bryophyte is *Schistochila undulatifolia* (Schistochilaceae) (IUCN 2008). In the event of forest damage, the presence of brophyte is threatened. Therefore, bryophyte needs to be observed and maintained its existence.

Mount Andong is a mountain that has not shown volcanic activity for a long time. This mountain is often visited by climbers at an altitude ± 1726 meters above sea level (mdpl). Andong mountainside forest area is a type of tropical mountain forest that has a fairly diverse vegetation species composition (Ardiyanto 2014). But so far the scientific data that the andong mountainside forest has is still lacking, especially regarding the types of bryophyte. Therefore, further research is needed to produce more complete scientific data.

MATERIALS AND METHODS

The research was conducted in Sawit Hiking Trails of Mount Andong which belongs to the Ngablak Sub-district, Magelang Regency. Research site at an altitude of 1330-1430 mdpl. The study was conducted in February-March 2020. Before retrieving data on bryophyte types, abiotic parameters are measured first. These parameters include light intensity, soil pH, soil moisture, and air temperature. Sampling is using purposive sampling method, samples are taken at locations that can be reached along the hiking path of various substrates (trees, weathered wood, soil, rocks). Each find bryophyte photographed, identified, and recorded on the tally sheet. Plants that are not immediately identified are coded and written on the tally sheet based on the code in the photo name.

Bryophyte that have been found are identified by looking at morphological traits based on photographs or using supporting specimens taken. It is further identified through the determination key and by the appropriate library as well as through the specimen image comparison literature.

RESULT AND DISCUSSION

The results of bryophyte diversity study obtained 28 genera from 21 families. Here is a list of bryophyte genus found in Sawit Hiking Trails of Mount Andong :

Table 1. Bryophyte diversity in Sawit Hiking Trails of Mount Andong

Family	*Genus/Spesies*	*Substrate*
Aytoniaceae	*Asterella*	Rck, So
Marchantiaceae	*Marchantia*	So
	Marchantia polymorpha	So
Pallaviciniaceae	*Pallavicinia*	So
Lejeuneaceae	*Lejeunea*	Rck, St
Jungermanniaceae	*Jungermannia*	Rck, So
Lophocoleaceae	*Heterosciphus coalitus*	So
Polytrichaceae	*Pogonatum*	So
	Polytrichum	So
Calymperaceae	*Campylopodium khasianum*	Rck, So
Dicranaceae	*Dicranum*	So
	Octoblepharum albidum	Rck, So
Fissidentaceae	*Fissidens*	Rck, St, So

Leucobryaceae	*Leucobryum*	St, So
Rhabdoweisiaceae	*Dicranoweisia*	Rck
Pottiaceae	*Didymodon*	St
	Hyophila	Rck
	Scopelophila	St
Bryaceae	*Bryum*	Rck, So
	Pohlia	Rck, So
Mniaceae	*Mnium*	So
Plagiomniaceae	*Plagiomnium*	So
Brachytheciaceae	*Brachythecium*	Rck
	Homalothecium	So, Rck, St
	Rhynchostegium	So
Hypnaceae	*Hypnum*	So
Thuidiaceae	*Thuidium*	St, So
Anthocerotoceae	*Anthoceros*	So
Notothyladaceae	*Phaeoceros*	Rck, So

Description :
So : Soil
St : Stem
Rck : Rocks

Brophyte diversity in Mount Andong (Sawit Hiking Trails) includes 6-families of Marchantiophyta (4 genera), 13-families of Bryophyta (20 genera), and 2 families of Anthocerotophyta (2 genera). Gradstein (2011) in Romawati (2013) Marchantiaceae and Ricciaceae are common bryophyte found in Java. The family Aytoniaceae and Marchantiaceae are the bryophytes of the laced liver found in this study namely *Asterella* and *Marchantia*. Based on the data flawed in the book titled "Status of Indonesian Biodiversity" by Retnowati *et al*. (2019), Pallaviciniaceae consists of 6 species found in Indonesia with spreads on the islands of Java (6 types) and Sulawesi (1 type). The genus found in the study is *Pallavicinia*. Bryophyte in the family Rhabdoweisiaceae in Indonesia is found only on the island of Java and there is only one type (Retnowati *et al*. 2019).

Anthocerotophyta in Java has three families: Notothyladaceae (*Notothylas*), Anthocerotaceae (*Anthoceros, Folioceros, Phaeoceros*), and Dendrocerotaceae (*Dendroceros, Megaceros, Paraphymatoceros*) (Gradstein 2011 in Romawati 2013). However, the latest classification system based on the phylogeni Tch Cole *et al*. (2019) places the genus *Phaeoceros* into the family Notothyladaceae. Anthocerotophyta found at the research site are *Anthoceros* and *Phaeoceros*.

Aytoniaceae

Thalus pores are simple, antheredium appears on the surface of the dorsal thalus. The family consists of five genera. At the research site only found one genus namely *Asterella*. It is one of the genus in the largest order Marchantiales consisting of 45-50 species worldwide. Thalus are medium to relatively large in size and have dichotomy branches. Pale surface colors of green, sometimes with a reddish color, are not uncommon in older parts to become reddish-brownish. Gemmae cups are rare. Monoecious and some are dioecious. Archegonia wrapped by involukrum (Long 2005).

Marchantiaceae

This family has the main characteristic of gametangium found in a long-stemmed buffer or supporter (reseptakel) (gametangiofor). Gametofit is a ribbon-like thalus, rather thick, fleshy, forked and has one middle rib. Thalus sheets are shaped like hearts. The types found are *Marchantia* Polymorpha and *Marchantia Linearis*. *M. Polymorpha* is a liver bryophyte with the largest thalus, thick and rigid while *M. Linearis* thalus is small and thin. In *M. Linearis* there is a middle median line on the black thalus. Thalus in the genus *Marchantia* branches out into dichotomy and has gemmae cup (bud) as an asexual reproductive tool (Suhono 2012). Lukitasary (2018) writes that *Marchantia polymorpha* is used as a hepatitis drug. This bryophyte has been used as a folk remedy in China, Europe, and North America.

Pallaviciniaceae

Thalus is simple and there are thick veins in the middle that are dark in color. The family consists of 8 genera spread around the world except Antarctica (Suhono 2012). At the research site only found one genus, *Pallavicinia*. Gametofit is laced and membraneus. On the surface of thalus there is no air space as in the Marchantiales. The genus consists of about 30 species, and is mostly spread across the southern hemisphere (Smith 1990).

Lejeuneaceae

It consists of 94 genera and 1600 species, the largest group in the Marchantiophyta division (Suhono 2012). Lejeuneaceae can be identified by the arrangement of leaves that accumulate which when viewed from the top (dorsal) is seen each leaf covering a portion of the leaves above it (incubous). There are two kinds of leaves, namely a larger lobe and a relatively smaller lobulus (Haerida 2009 in Khairrani 2018). Lejeunea is the largest family of the family Lejeuneaceae of 300 species. The characteristic is to have small leaves growing in rows on the left and right sides of the thalus with a three-row arrangement of leaves (Suhono 2012).

Jungermanniaceae

Rounded and cylindrical thalus overgrown by 2 or 3 rows of leaves with thin green sheets. The leaves grow ducking or perforating, the leaves are not perforated and grow fully along the thalus and rizoids are spread evenly along the thalus. The family consists of 5 genera spread over temperate regions, a small part of which grows in the tropics (Suhono 2012). *Jungermannia*. Soft body with two rows of leaves. The leaves are arranged on the right and left called lateral leaves. The arrangement of lateral leaves can be incubous (lower leaves cover the upper leaves) and sucubous type (upper leaves cover the lower leaves such as the roof tile arrangement of the house). Rizhoids are not branched, sporogonium is formed in capsule-shaped

archeegonia. The shape of the egg round leaves, flat edges, and no costa (Sujadmiko et al. 2015).

Lophocoleaceae

The plant is whitish green, yellowish green or pale green. Vegetative breeding by gemmae or flagelliform branches. Lateral branching, round capsules of eggs until cylindrical. Spread across the tropical and southern hemispheres. It consists of 21 genera (Smith 1990). The type found is *Heteroschipus coalitus*. Plants are small, light green to yellowish green in wet conditions. The arrangement of lateral leaves is adjacent, the lobe is rectangular or almost square with 2 small teeth at the edge of the leaf.

Polytrichaceae

Species in the family Polytrichaceae have leaves that grow circular green in the shape of a lanset, netted, and pipe-like thin with pointed ends. It consists of 20 genera (Suhono 2012). At the research site there were only 2 genera namely *Pogonatum* and *Polytrichum*. The two genera are very similar at first glance but the *Pogonatum* leaves are lanset and thick while in *Polytrichum* the leaves are not thick and coated in cuticles (Sujadmiko et al. 2015). Basile *et al*. (1998) in Lukitasary (2018) says that the benefits of *Pogonatum* as a garden decorator and *Polytrichum* are used as pillow stuffing as well as having compounds used for antimicrobials. Some other types of bryophytes that have compounds used for antimicrobials (antiseptics) are *Dicranum* (Dicranaceae), *Mnium* (Mniaceae), and *Hypnum* (Hypnaceae).

Calymperaceae

Acrocarpous (sporophytes are found at the end of the main rod). There is only 1 genus (*Mitthyridium*) whose primary stem creeps. The shape of the leaves varies and has costa, the type of the leaves varies, and belongs to the dioecious (two-house) group as well as the relatively small sporophytes. The spread is mainly in the tropics and sub-tropics (Eddy 1990). Stems are dark green to yellowish brown. A single set of yellow becomes red, mostly elongated, smooth, and upright. The capsules are upright and yellowish in color, mostly cylindrical in shape. Habitate on bark is mainly on rotting wood, stone, and soil (Reese 2007).

Octoblepharum albidum. The color of the leaves becomes somewhat white during dryness. Thalus grows upright and branches at its base. The population of this moss is medium or small with a lushness that is not very tight. The leaves are yellowish green, light green to white. The shape of the leaves is lanset and the color is shiny. This type of bryophyte breeds with spores and is rarely vegetative. If anything, with buds (gemmae) growing on branches. The spread of this bryophyte in addition to Indonesia is in the Americas, Africa, India, Sri Lanka, Vietnam, China, Myanmar, Thailand, Malaysia, Philippines, Papua New Guinea and Australia (Suhono 2012).

Dicranaceae

Dicranaceae has an ovale leaf, lanset or round egg until it sprouts with a pointed tip and grows around the thalus. It consists of 41 genera (Suhono 2012). At the site of the study were found 2 genera namely *Campylopodium* (*Campylopodium khasianum*) and *Dicranum*. Sujadmiko *et al*. (2015) writes that Campylopodium *khasianum* thalus is covered in leaves and looks like hanging threads. Thalus has branches at the base so it looks lush. *Dicranum* has spiky leaves with flat leaf edges and no leaf bones. The location of the leaves spreads with the direction of growing only upwards or vertically.

Fissidentaceae

A smooth texture, the leaves consist of two vaginal lamina clamping stems, a ventral lamina located above the vaginal lamina, and a lamina back that occupies the length of the leaf opposite the vaginal and ventral lamina, a single kosta. Seta elongated, cylinder capsule. The family has only one genus, *Fissidens* (Pursell 2007). *Fissidens* have flat leaves and has leaf bones (costa), the edges are sometimes bordered. The shape of the lamina varies depending on the type of *Fissidens*. Long seta and in general upright capsules. Live colonized in moist places, on rocks, or on trees. Sexual reproduction by forming gametangium and asexual with buds or gemmae. The genus consists of 450 species spread around the world but mostly in the tropics (Sujadmiko *et al*. 2015).

Leucobryaceae

The leaves are thick sheets with leaf bones extending to the ends. The shape of the leaf is lanset or somewhat striped that grows from the bottom of the thalus. Spores are twisted, straight and grow from the thalus terminal. Thalus has branches and the main htalus does not develop into a large one. The colour is light green, bluish green, grayish, or light brown. There are 13 genera and 155 species spread around the world mainly in temperate, tropical, or subtropics (Suhono 2012).

Leucobryum. The genus is rarely found growing in groups, sometimes found along with other leaf bryophyte. The gametofit form in the form of leaves that grow densely and dempetan. The color of the leaves is shiny light green, narrow and elongated, sometimes at the end is easily curved, the ends of the leaves tapered, with a blunt base. Sporophyte forms merge between stems (meyerupai stems) or branches with each other, forming a fused root. Round capsules and branched rizhoids (Edawua 2012).

Rhabdoweisiaceae

Plants are very small to medium in size, solitary or form short tassels. The stem is short, simple or slightly forked. Leaves are mostly lanset, lanceolate or subulate, and single costa. No asexual structure, and is monoecious. Short sets are elongated, erect or curved and finely textured (Frahm 2012). *Dicranoweisia*. Medium-sized plants, branched stems, ovate or lanset-shaped leaves, acuminate or subulate. Capsules are straight, smooth and symmetrical (Casas *et al*. 2006).

Pottiaceae

Acrocarpous (sporophyte is found at the end of the stem), the shape of the leaves is tongue-like and the ends of the leaves tapered. The edges of the leaves without teeth, usually bend downwards or bend upwards and the leaves bone is clear. The mosses found are *Didymoodon*,

Hyophila, and *Scopelophila*. *Didymodon* has leaves shaped like tongues or lansets with flat edges and pointed ends. The arrangement of leaves intermittently intersses tightly so that they appear to accumulate with each other (Werner *et al*. 2005). While *Hyophila* leaves are generally egg-shaped, oblong or elliptical. *Scopelophila* forms thin or thick grass with clustered leaves (Casas et al. 2006).

Bryaceae

Bryaceae has lanceolate or ovate-shaped leaves. At the site of the study, only two genera were *Bryum* and *Pohlia*. *Bryum* leaves are crammed at the top of the stem or regularly along the stem, lanset-shaped, ovate, lanceolate or spathulate. While the leaves of *Pohlia* are ovate-shaped into lanset (Casas *et al*. 2006).

Mniaceae

The leaves are green with a lanset shape or linear lanset until oblong with tapered or rounded ends. Fine leaf bones, capsules are cylindrical and have caliptra. The family consists of 13 genera spread around the world mainly in tropical and subtropical regions including North America, Canada, Europe, Asia (Japan, China, Taiwan, Indonesia), and Australia (Suhono 2012). *Mnium*. The height of the stem reaches 4-5 cm, generally not branched. Ovale and frayed capsules (Casas *et al*. 2006).

Plagiomniaceae

Male and female plants have different morphology. The difference is that it includes the shape of the leaf, the size of the cell, and the margin teeth (edges) of the leaves. *Plagiomnium* has straight-growing shoots with leaves arranged in 3 sterile rows and growing creeping. Capsules are egg-shaped until ovale, oblique or frayed (Casas *et al*. 2006).

Brachytheciaceae

One of the largest families among pleurocarpous bryophyte (sporophytes are located laterally on the stem). Irregular branching, pointy leaf tips, and bony leaves one. It consists of about 250-350 species and 41 genera (Huttunen 2004). There are only 3 genera found at the research site namely *Brachythecium*, *Homalothecium*, and *Rhynchostegium*. The genus *Brachythecium* is one of the most complex and diverse bryophytes of its genus in terms of morphological variations in the family Brachytheciaceae. The genus consists of about 150 species in the world (Crosby *et al*. 1999, Frey & Stech 2009 in Orgaz 2012), monoecious (anteredium and archaegonium in one plant) and some are dioecious (anteredium and arkegonium in different plants). *Homalothecium* is dioecious while *Rhynchostegium* is monoecius (Casas *et al*. 2006).

Hypnaceae

The family consists of 65 genera spread around the world (Suhono 2012). It is a bryophyte group of leaves that grow spread (pleurocarpus), medium size, usually shiny leaves, irregular branched stems and can bond strongly, so as to form a stretch that envelops the tree (Nadhifah *et al*. 2017). *Hypnum*. Plants are colored, green, yellowish or brownish, usually shiny. Stems rarely branch. The leaves of the branches are similar to the stem leaves. Seta reddish, capsules are straight or curved, perpendicular to horizontal. Monoecious and some are dioecious (Casas et al. 2006).

Thuidiaceae

It consists of 30 genera with 304 species spread around the world except Antarctica and the Arctic. Upright/creeping thalus, mace/single leaf vein. Thalus has branches similar to the compound leaves of *Selaginella*. Some are monoecious and some are dioecious, but they are generally dioecious. Spore capsule stalks are long and reddish in color, and spore capsules have anulus (ring) (Suhono 2012). Stems branch a lot, often brushing regularly 2 or 3 times. The branch leaves are smaller and well differentiated, rounded eggs, concave, short-tipped, stiff (Br and Schimp 1852 in Windadri 2007).

Thuidium. Dioecious, stem leaves are mostly triangular, deltoid or round eggs. The length is 2.0–5.5 cm and is usually smooth and has fine caliptra. Thuidium consists of 20-25 species. Common species are found in the northern hemisphere, tropics, South Africa, and temperate parts of Australia (Touw 2012).

Anthocerotoceae

Sporogonium is long, cylindrical, and grows upright in the middle of the talus surface. Capsule wall cells contain chloroplasts and there are stomata. In the capsule there is columela (Susarsi and Sri 1999). Based on the most recent classification in Cole *et al*. (2019), the family consists of only 3 genera namely *Anthoceros*, *Sphaerosporoceros*, and *Folioceros*. Smooth thalus surfaces such as velvety, slippery, or choppy. On the ventral surface of the thalus there is a fine rizoid. In the htalus tissue there is a space between cells containing Nostoc colonies and full of mucus (Sujadmiko *et al*. 2015).

Anthoceros. Sometimes it grows or lives with other bryophyte. Irregularly notched gametofit, a long capsule-shaped sporophyte with curved, black ends. It is commonly found in low-temperature areas and some are near high-temperature streams, and many cling to moist rocks and soil (Edawua 2012).

Notothyladaceae

Sporogonium is short, grows horizontally and is found on the edge of the thalus. Capsule walls do not have chloroplasts and stomata. The base of the sporogonium is not shrouded involukrum (Waldi 2017). *Phaeoceros*. The genus consists of 41 species. It spreads around the world, but mostly in the tropics. Thalus is solid, has stomata. Spores are yellow to brownish when completely ripe (Villarreal *et al*. 2010).

CONCLUSION

The bryophyte diversity in Sawit Hiking Trails of Mount Andong Magelang Regency consists of 28 genera from 21 families. The family Pottiaceae and Brachytheciaceae are the families that have the highest number of genus: 3 genera; family Polytrichaceae, Dicranaceae, and Bryaceae (2 genus); and other families are only 1 genus. The most commonly found is leaf bryophyte (Bryophyta).

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