Jurnal Riset Biologi dan Aplikasinya
https://journal.unesa.ac.id/index.php/risetbiologi

Diversity of Moss Species (Bryophyta) In Senggani Ravine Tourism Area, Tulungagung Regency

Desi Kartikasari*, Gading Anon Widodo, Nur Habibah, Rakhmi Zahratul Asna
UIN Sayyid Ali Rahmatullah
Jln. Mayor Sujadi No.46, Kudusan, Plosokandang, Kedungwaru, Tulungagung Regency, East Java, 66221, Indonesia
*Corresponding author
e-mail: desi.kartikasari88@gmail.com

Article History

Received : 18 November 2023
Revised : 4 February 2023
Accepted : 12 March 2023
Published : 31 March 2023

Keywords

Biodiversity assessment; bryophytes; Indonesia; plant taxonomy

ABSTRACT

Moss plants (Bryophyta) are found in every habitat, and their presence in an ecosystem is controlled by environmental circumstances. The Senggani Ravine tourism area is a popular tourist attraction comprising a pine forest with extensive moss communities. This work aimed to assess the diversity of mosses (Bryophyta) in the Senggani Ravine tourism area for the first time. In June 2022, exploratory descriptive research of moss diversity was undertaken by a free walk around the Senggani Ravine tourism area from a predetermined position point (purposive sampling) using observation, documentation, literature study, and measurement of abiotic elements for data collection. Based on the results, twenty species of mosses were identified and can be divided into four classes, namely the Bryopsida, Polytrichopsida, Jungermanniopsida, and Marchantiopsida. The species identified were *Barbulla indica*, *Fissidens purpusillus*, *Fissidens biformis*, *Fissidens biformis*, *Octoblepharum albidum*, *Rhizonium punctatum*, *Mnium hornum*, *Philonotis marchica*, *Fontinalis antipyretica*, *Hypnum cupressiform*, *Polytrichastrum formosum*, *Lejeunea flava*, *Lejeunea cavifolia*, *Bazzania prareupta*, *Bazzania vittata*, *Riccia junghuhniana*, *Marchantia emarginata*, *Marchantia polymorpha*, *Dumortiera hirsuta*, *and Lunularia cruciate*. Abiotic factor measurements revealed that zone 3, which has a soil pH of 6, an air temperature of 24.1 C°, an 84% humidity level, and 200 Cd of light cm^{-1}, is the most favorable area for moss growth. We can infer that the Senggani Ravine tourism area is still primarily undisturbed because the moss flora is still quite diverse and varied.

How to cite: Kartikasari, D., Widodo, G.A., Habib, N., & Asna, R.Z. (2023). Diversity of Moss Species (Bryophyta) In Senggani Ravine Tourism Area, Tulungagung Regency. *Jurnal Riset Biologi dan Aplikasinya*, 5(1):43-51. DOI: 10.26740/jrba.v5n1.p.43-51.

INTRODUCTION

Senggani Ravine is a tourist destination in Nglurup Village, Sendang District, Tulungagung Regency. Known for its campgrounds and home to a magnificent pine forest, it is a popular tourist attraction. It features a cool and humid microclimate and has fertile soil. The predominance of dense and gloomy trees, as well as grass and other vegetation indicates that these environmental circumstances enable the establishment of various species like mosses (Effendi et al., 2018). Mosses (Bryophyta) are a group of plants with 15,000 species, the second largest after the flowering plants that dominate the Indonesian mainland. The presence of mosses in an ecosystem is influenced by environmental circumstances. Mosses grow in every habitat. They are able to live and grow on a variety of surfaces, including soil, rocks, sand, litter, tree trunks, and even water. Numerous abiotic elements can affect the growth of mosses (Mulyani et al., 2015). According to Bawaihaty et al. (2014), environmental circumstances such as temperature, humidity, light, altitude, climate, and availability of nutrients have a significant impact on the population and variety of mosses within an ecosystem.

The growth of mosses exerts positive effects on the local ecosystem, particularly for other plants. Using rock mineralization, decomposition, and carbon fixation, mosses have the potential to balance the nutrient content of the soil (Lukitasari, 2018). According to Perwati et al. (2015), mosses

play a significant role in tropical forest areas, particularly in highland regions. In addition to serving as a home for other organisms, moss plants also serve as groundwater balancers, oxygen suppliers, nutrient cycle inhibitors, ornamental plants, medicinals, and are able to detect pollution levels or environmental changes. Research on the variety of mosses in the Senggani Ravine tourism area, is conducted due to their significant ecological function and to address the lack of existing studies on mosses in the region. This reseach aimed to assess the diversity of mosses (Bryophyta) in the Senggani Ravine tourism area. By doing this research, it is anticipated to reveal more about the variety of mosses there and their ecological advantages.

MATERIALS AND METHODS

Location and time of observation

The research was carried out in the Senggani Gorge region, Nglurup Village, Sendang District, Tulungagung Regency in June 2022. Senggani Ravine is a region in the highlands that is about 800 m above sea level, has an average temperature of 25.6 C°, and 82.3% relative humidity. Sampling involved *in situ* research through direct observations by researchers in their natural environments (Moelong, 2017). This research employed a descriptive exploratory strategy with *cruising* approaches (Sundra, 2016). By using three specified observation points (purposive sampling) as a reference for the observation area that can be shown on a map, researchers used free roaming (cruising method) to directly explore the Senggani Ravine tourism area (Figure 1).

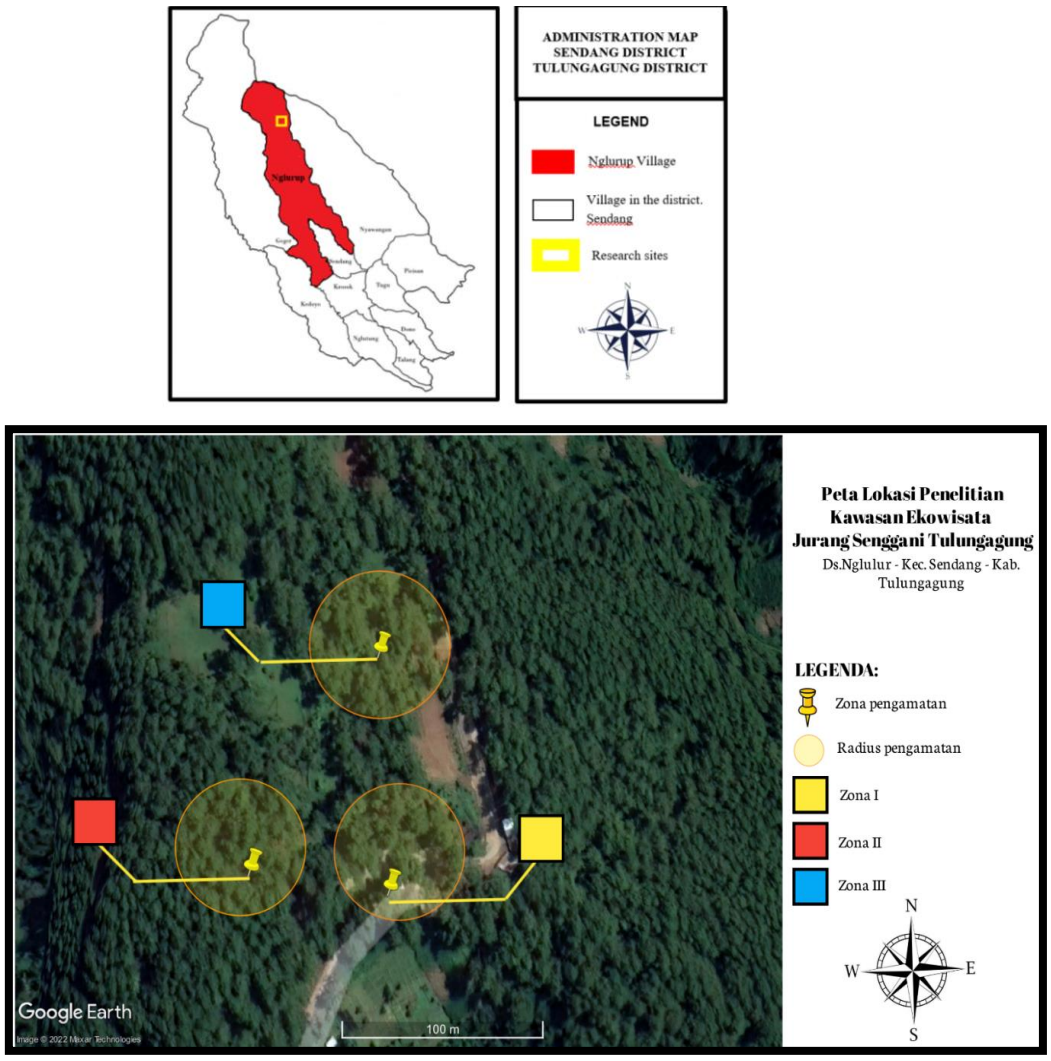

Figure 1. The Senggani Ravine tourism Area, Nglurup Village, Sendang District, Tulungagung Regency are all included on a map of the research locations

Zone I is at the coordinate point (S 07°54'57.19" E 111°49'34.05"), Zone II is at the coordinate point (S 07°54'53.44" E 111°49'33.80"), and Zone III is at the coordinate point (S 07°54'57.00" E 111°49'31.88"). This research was not focused on establishing a particular hypothesis but limited to descriptions being observed using tools for gathering observation data, documentation, and literature studies (Arikunto, 2002). A Realme 3 Android camera and a Nikon 25 mm prosumer macro lens, as well as writing supplies and books for identifying mosses, were used in the investigation. References such as Lukitasari (2016; 2018) and additional sources including articles, journals, and books were consulted. Instruments for measuring abiotic factors were employed (anemometer, GPS ETREX30X, AZ 885 Infrared Psychrometer, Three Way Soil Meter, and MA-30 Military Altimeter EX 284). Following collection, the specimens were identified and given a descriptive analysis based on their traits and abiotic components.

RESULTS AND DISCUSSION

Moss species diversity (Bryophyta)

The research identified 20 species of mosses (Bryophyta) that are native of Senggani Ravine tourist area. A total of 20 species were collected, classified into 15 moss plant families comprising 11 moss/leaf moss species (Bryophyta) and 9 liverwort species (Marchantiophyta) (Table 1). According to field observations, zone III exhibited up to 13 more species than zones I or II combined, which is the highest level of species diversity. Moss plants can grow on a wide range of surfaces, including soil, rocks, tree roots, tree trunks, weathered logs, and cliffs edge.

The mosses that dominated the Senggani Ravine tourism area belonged to the Bryophyta division (leaf/true mosses) (Table 1) which is the group of moss plants with the highest number of species in the world when compared to other moss groups, which is estimated at 12,000 species (Mulyani et al., 2015). According to research by Goffinet et al. (2008), the Bryopsida class, which encompasses 95% of the moss species globally, is the biggest group of mosses. True mosses with leaves (Bryophyta) are classified as having a greater level of development than other forms of mosses, in which stems can already be distinguished from leaves.

When compared to earlier studies on mosses, such as those carried out at Peucari Bueng Jantho Waterfall, Aceh Besar District by Raihan et al. (2018), a relatively high diversity of moss species was observed by Azwir et al. (2022) in the forest of Mesjid Raya District, Aceh Besar District, and by Endang (2020) along the Kaburan-Burana River Basin, Batauga District, South Buton Regency, but further study is needed. Other studies were also undertaken in the vicinity of Mount Ungaran by Mulyani et al. (2015), and on Mount Prau, Blumah, Central Java region by Linah et al. (2021). Some of these variations in yield may be the consequence of various and unique environmental factors impacting upon the capacity of certain moss species to develop and adapt. Furthermore, human actions such as land clearing those results in increased light intensity in the moss habitat, as well as other environmental degradation, might alter the variety of moss species in certain areas (Liannah et al., 2021).

Figure 3 illustrates the variations between the properties of mosses belonging to the Bryophyta (true mosses) group. Bryophyta, or true mosses, typically consist of entire plant-like structures (roots/rhizoids, leaves, and stems). On the stems of moss, which have upright, spirally arranged leaves, buds grow for reproduction. Leaf/true mosses are able to grow on soil, grass, rock, tree trunks, and roots. Andreaeales, Sphagnales, and Bryales are the three orders that comprise the group of true mosses (mosses) (Lukitasari, 2018).

Barbula indica

Barbula indica has a height of 5-15 mm, smooth brown rhizomes, stems erect and occasionally branched, dark brown to reddish brown. Lanceolate leaves, grow upright on the stem, when dry the leaves will turn brown. The arrangement of the leaves is alternate, dense so that it looks stacked on top of each other, with small toothed leaf margins, leaf tips rounded, large costa ending at the leaf tip. Setae erect, occasionally bent, measuring 1 cm or more, capsules are round, cylindrical, measuring 1.5 mm and have an elongated capsule cover. This type of moss is found growing in groups, dense and growing upright on calcareous soil with open environmental conditions. Eddy (1998) argues that *Barbula indica* is a small, green or yellowish plant with a height of more than 1 cm. Stem simple or branched. Leaves narrow, apex (leaf tip) rounded, often emarginated (heart-shaped). Setae short, spherical cylindrical capsule, up to 1.5 mm long, narrowly conical capsule cover. It grows on rocks, soil and walls, especially in damp and calcareous places.

Fissidens perpusillus

This plant has a flat form, shoots that grow vertically, varying body sizes, a yellowish-green hue, and a filoid fingered, pointy tip (Ristanto et al., 2021). The stems are so short and concealed by

leaves that they appear to be nonexistent. The stems are short and completely covered by leaves. On the stem, the leaves are organized in two rows, are lanceolate, have flat, small-toothed margins, and are pointy at the tip/base. Fissidens perpusillus develops in clusters and spreads on moist and damp rock surfaces (Endang et al., 2020).

Fessidens biformis

Belongs to the Fissidentaceae group. Almost often found growing on rock substrate. It has a leaf morphology that is wide, upright and clustered, the tips are pointed, finger-like and stacked in a row, has a short stalk that is not visible, capsules and setae are about 1 cm long (Febrianti, 2015).

Fessidens astroviridis

Fissidens astroviridis is commonly found in soil substrates but is also found in rocks. This moss has a dull green color and looks comb-shaped when viewed from above (Febrianti, 2015). The individual size of *F. atroviridis* reaches 5 mm. The leaves are lanceolate with a pointed tip (Raihan et al., 2018). Leaf anatomy has a size of 1 µm with an irregular rectangular shape. The stem is almost invisible because it is covered with a collection of thread-like leaves and rhizoids. Environmental conditions have a significant influence on moss. Differences of each species of mosses to environmental factors will affect the level of adaptation, species composition, and distribution of mosses (Pasaribu, 2013).

Octoblepharum albidum

The leaves ranged in color from pale green to white, have an elongated, pointed form, and are thick. The sporophyte of *O. albidum* is readily discernible. The top of the sporangium is known as the spore box. It forms colonies and adheres to the stem of pine trees and is found in both wet and dry forests. Therefore, the Senggani Ravine tourism area is an ideal habitat for *O. albidum* because it is shady and cool.

Rhizonium punctatum

The oval leaves of this plant, which frequently grow next to one another, shrink when dry. *R. punctatum* has dark red stems that eventually turn reddish-brown as they mature. Green protonematous rhizoids specialize in asexual reproduction. This species inhabits dark, moist, and damp soil and rocks (Tomovic et al., 2021).

Table 1. List of the bryophytes (mosses) that can be found in Senggani Gorge

No.	Scientific Name	Family	Substrate	Location		
				Zone 1	Zone II	Zone III
		Leaf moss (Bryophyta)				
1	*Barbulla indica*	Pottiaceae	Soil, rocks	-	+	-
2	*Fissidens purpusillus*	Fissidentaceae	Rocks	+	-	-
3	*Fissidens biformis*	Fissidentaceae	Tree trunks	-	-	+
4	*Fissidens astroviridis*	Fissidentaceae	Soil	+	+	+
5	*Octoblepharum albidum*	Leucophanaceae	Soil, tree trunk	-	+	+
6	*Rhizonium punctatum*	Mniaceae	Soil, rocks	-	+	+
7	*Mnium hornum*	Mniaceae	Soil	-	-	+
8	*Philonotis marchica*	Bartramiaceae	Soil	+	-	+
9	*Fontinalis antipyretica*	Fontinalaceae	Soil	-	+	-
10	*Hypnum cupressiforme*	Hypnaceae	Soil, rocks	+	+	+
11	*Polytrichastrum formosum*	Polytrichaceae	Soil	+	-	-
		Liver moss (Marchantiophyta)				
1	*Lejeunea flava*	Lejeuneaceae	Soil, roots, rocks	-	-	+
2	*Lejeunea cavifolia*	Lejeuneaceae	Soil, roots, rocks	-	-	+
3	*Bazzania prareupta*	Lepidoziaceae	Soil, weathered wood	-	+	-
4	*Bazzania vittata*	Lepidoziaceae	Soil, weathered wood	+	+	+
5	*Riccia junghuhniana*	Ricciaceae	Soil	-	+	-
6	*Marchantia emarginata*	Marchantiaceae	Soil	-	-	+
7	*Marchantia polymorpha*	Marchantiaceae	Soil	+	-	+
8	*Dumortiera hirsuta*	Dumortieraceae	Soil, rocks	+	-	+
9	*Lunularia cruciata*	Lunulariaceae	Rocks	-	+	-

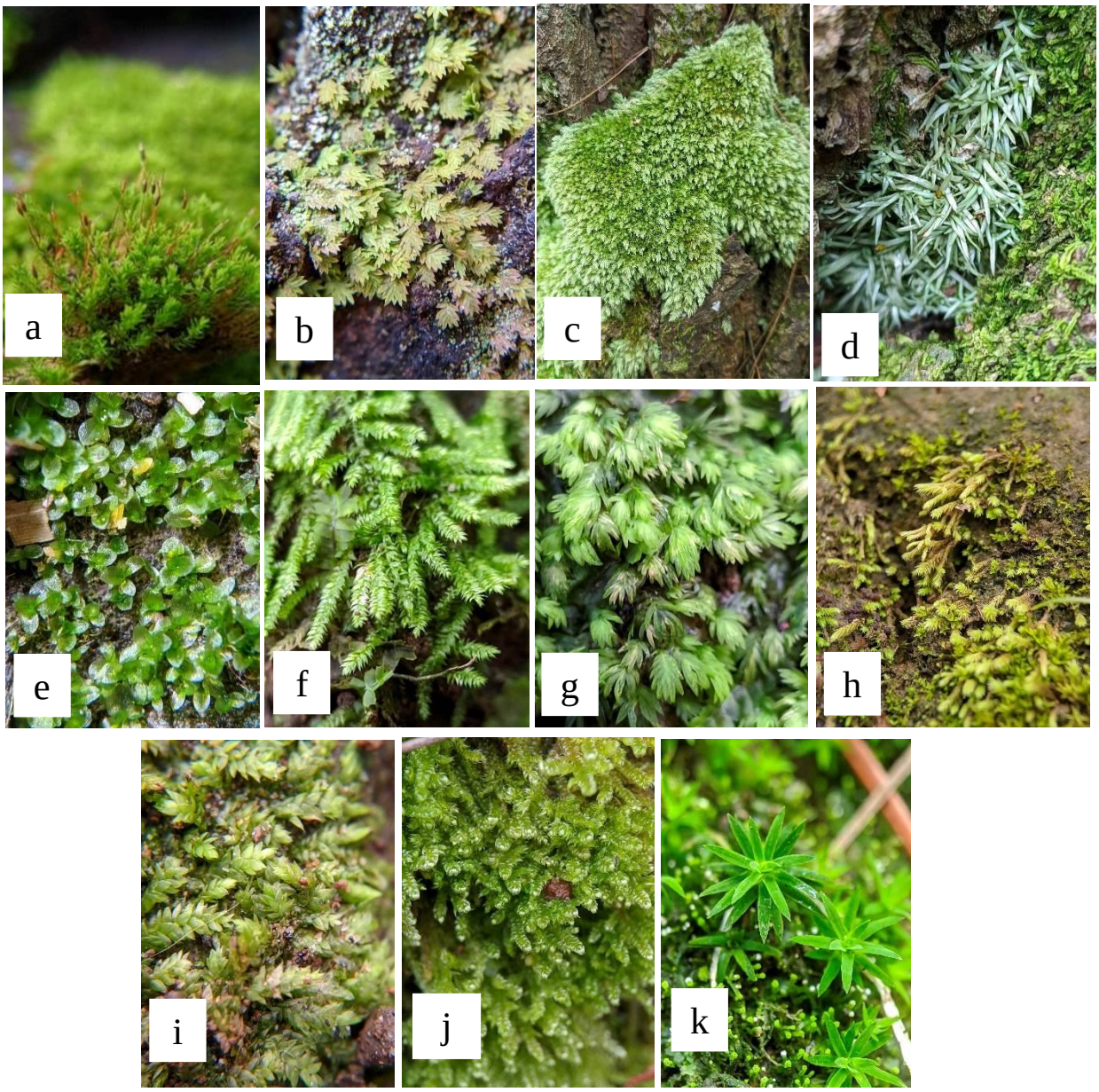

Figure 3. Leaf mosses (Bryophyta) were found in the Senggani Ravine tourism area. a. *Barbulla indica* b. *Fissidens purpusillus* c. *Fissidens biformis*, d. *Octoblepharum albidum*, e. *Rhizonium punctatum*, f. *Mnium stellare*, g. *Mnium hornum*, h. *Philonotis marchica*, i. *Fontinalis antipyretica*, j. *Hypnum cupressiforme*, k. *Polytrichastrum formosum*

Mnium hornum

The leaves of *Mnium hornum* are distinctively golden green in color, slightly elongated, and have a pointed leaf tip. This moss species thrives on moist and humid soil (Marom et al., 2017).

Philonotis marchica

The spores of *Philonotis marchica* are round. The leaves are green, weeny, serrated, and arranged along the stems. The cells of the leaf blades appear to be wider near the base. It can survive on moist and damp soil surfaces.

Fontinalis antipyretica

It can grow transversely branched and reach up to 60 cm in length. Its leaves are oval, slightly stiff, and arranged in an overlapping pattern. There are tiny spores on this moss plant at the time of collection. This huge moss can be seen growing on damp, wet rocks and soil (Lukitasari, 2018).

Hypnum cupressiforme

Hypnum cupressiforme is a species of moss that may grow on damp surfaces of soil and rocks. Its green leaves are long, curled, and have pointed tips. Because the leaves grow densely on the stem's surface, the stem is almost completely covered by

the leaves. The branches are irregularly pinnate and the branches either spread or ascendant.

Polytrichastrum formosum

Polytrichastrum formosum is a medium-sized plant with tall and unbranched main stems. The leaves bloom like flowers and become dull when dry. On the leaf surface, tall lamellae cells can be detected. This species can be found on moist and damp soil surfaces as well as flooded soil surfaces (Asthana et al., 2012).

Liveworts (Marchantiophyta)

Figure 4 depicts the species of liverworts (Marchantiophyta) discovered in several zones of the research area, with apparent variances in their characteristics. Liverworts are distinguished from other mosses by the presence of a thallus connected to the substrate and leaves made up of lined and thickened cells. The genital organs of liverworts are usually found on the surface and are protected by a unicellular root structure (Lukitasari, 2018).

Lejeunea flava

Lejeunea flava features a small and pale green circular thallus, varied leaf sizes between large (lobes) and small (lobules), and flat and blunt edges. Small trunk, dense, creeping, and branching growth.

The branching, however, is almost unnoticeable since it is covered with an incubous leaf arrangement (lower leaves covering the top leaves) or overlaps. *L. flava* colonizes soil, trees, and rock substrates (Angeles et al., 2020).

Lejeunea cavifolia

The trunk of *Lejeuna cavifolia* is dense, flat, and interwined with soil, bark, roots, and pebbles. It has a small thallus that is spherical, smooth, and pale green. This moss's stem spreads over the substrate, usually with two uneven branches, the edges are flat and blunt, the lower leaves covering the higher leaves or overlap each other, and it is divided between large leaves (lobes) and little leaves (lobule). *L. cavifolia* grows on rotten wood, roots, rocks, and soil in shaded and moist areas (Putna and Mezaka, 2014).

Bazzania prareupta

The leaves of *Bazzania prareupta* are almost square in shape, green in color, flat at the basal borders, and rounded at the ends with a slightly curved inward center. The leaves are *succubous* (two upper covering the lower leaf), have cilia (tapering at the tip of the leaf), and have amphigastria. It has a small stem that is covered with leaves, of the *Frullania* branching type, and is linked to soil and worn wood surfaces (Lestari and Ariyanti, 2017).

Bazzania vittata

Bazzania vittata has a little green stem with a trunk branch that looks like a Frulllania or is formed like a fork but is short and unusual. The leaves are closely packed, neighboring leaves overlap, the base of the leaf is flat, the ventral leaf is attached, the leaf edge is flat, and the top of the leaf is 2-3 serrated, blunt, and rough. The ventral leaves are closely spaced, circular to the square in form, and have thin walls. B. Vittata is frequently found clinging to soil substrates and worn wood (Lestari and Ariyanti, 2017).

Riccia junghuhniana

Riccia junghuhniana Nees & Lindenb belongs to the Ricciaceae family. *Riccia junghuhniana* is a liverwort that grows on the surface of the substrate like on the ground. *R. junghuhniana* has a thalus that is flush with the substrate, has midribs on the dorsal side of the thalus. Thalus branched dichotomous, light green and shiny. Live in groups by forming floral or circular patterns. When it has dried the thallus is yellowish in color (Lianah, et al., 2021).

Marchantia emarginata

Marchantia emarginata has a branched and stiff thallus that is dark green and leafless. It has a smooth surface, no midrib/midrib spreads across the soil surface, and when it is dried, the edges turn brown. The ribbon-like leaves of *M. emarginata* are distinguished by forked, fleshy branches and the presence of brood buds, despite the absence of a petiole on the stem. The thallus and the root are the only components of the gametophyte structure. Roots (rhizoids) aid in the attachment of the thallus to the substrate and are typically grouped in clusters (Wen and Huang, 2017).

Marchantia polymorpha

Marchantia polymorpha has a green thallus, no leaves, and grows creeping on the ground. The upper thallus has a hexagonal pattern, the tip and base of the thallus are blunt, porous, black striped, and has a thick stiff texture on the thallus (Febriansah et al., 2019). There is a *gemmae* cup, which is used for vegetative reproduction, and spores are used for generative reproduction. The archegonial stem is brownish green, and the archegoniophore is green, lobe-shaped like an umbrella. It has many roots (rhizoids) that aid in adhering to the soil surface (Sholihat and Kurnia, 2021).

Dumortiera hirsuta

Dumortiera hirsuta is a dark green ribbon-shaped plant with dichotomous branches. The thallus has a blunt, rounded tip with a V-shaped indentation in

the middle, a spore cup, and flat margins. The surface is slick and striped in a white hexagonal pattern, and there a few downy hairs. Similar to other forms of mosses, it uses rhizoid (roots) to adhere to the substrate. The substrate of *D. hirsuta* consists of soil and rocks (Karomah et al., 2020).

Figure 4. Liverworts (Marchantiophyta) spotted in the Senggani Gorge's tourism zone. a. *Lejeunea flava*, b. *Lejeunea cavifolia*, c. *Bazzania prareupta*, d. *Bazzania vittata*, e. *Riccia junghuhniana*, f. *Marchantia emarginata*, g. *Marchantia polymorpha*, h. *Dumortiera hirsuta*, and i. *Lunularia cruciate*

Table 2. Each zone's moss plant abiotic environmental conditions

Parameters	Location		
	Zone I	Zone II	Zone III
Air temperature (C°)	27.4	25.4	24.1
Humidity (%)	80	83	84
Light intensity (Cd)	500	250	200
Altitude of the place (m a.s.l)	815	818	838
Soil moisture (%)	6	7	7
Soil pH	7	7	6
Wind speed (m/s)	1.7	1.2	2.0

Environmental Factors

The environmental parameters affecting mosses in the tourism area of Senggani Ravine differ significantly in the three observation zones. However, in general, the climate in the Senggani Ravine is cold, humid, and chilly. Consequently, based on the measurements of environmental abiotic parameters, it has been determined that the environmental conditions in the Senggani Gorge tourism area are compatible with the features of the moss plant's habitat and conducive to its reproduction. Table 2 displays the abiotic environmental conditions of each moss zone.

Table 2 indicates that zone 3 has the highest altitude (838 m above sea level), is characterized by dense, shady trees, and has an air temperature of 24.1 C°. The air humidity is 84%, the light intensity is 200 Cd, the soil wetness is 7, the soil pH is 6, and the wind speed is 2.0 m s^{-1}. This substantially supports the habitat of moss plants where humidity and light intensity greatly affect the number of moss species, as proven by the fact that zone 3 is home to as many as 13 kinds of mosses. The intensity of sunlight has a significant effect on the air temperature and humidity, which in turn has a significant effect on the distribution of mosses. The less intense the sunshine, the greater the relative humidity and the lower the air temperature. The optimal air humidity for moss growth is between 70 and 98%, and soil pH has a significant impact on moss growth; moss thrives in the pH range of 4.9 to 8.3. (Wati, et al., 2016).

CONCLUSION

Based on the outcome of the research, it can be inferred that the diversity of mosses (Bryophyta) in the Senggani Ravine area is extremely diverse and varied, indicating that the area is still mostly undeveloped. There are 20 species of mosses (Bryophyta) divided into four classes: Bryopsida, Polytrichopsida, Jungermanniopsida, and Marchantiopsida. Zone 3 is a region that strongly favors moss habitat due to its height (838 m a.s.l), air temperature 24.1 C°, air humidity 84%, light intensity 200 candelas per square meter, and soil pH 6. As oxygen sources, water absorbers, pollutant absorbers, anti-erosion agents, aesthetic and medicinal plants, moss plants play a vital function in the environment.

REFERENCES

Angeles E. J. A., Magat B. M., & Jalandoni R. S. D. (2020). Distribution of Bryophytes in the University of the Philippines Diliman, Quezon City, Philippines. *Annals of Plant Sciences*, 9 (8), 3957-3969. https://doi.org/10.5281/aps.2020.9.8.1.

Arikunto, S. (2002). *Metodologi Penelitian Sudatu Pendekatan Proposal*. PT. Rineka Cipta. Jakarta.

Asthana, A.K., Sahu, V., & Nath, V. (2012). *Polytrichastrum formosum* (Hedw.) G.L. Smith in India. *Bryology Laboratory*, 33 (1), 87-90. https://doi.org/10.7872/cryb.v33.iss1.2012.087.

Azwir, Maulida, Jalaluddin., & Saputra, S. (2022). Inventarisasi Keanekaragaman Tumbuhan Lumut (Bryophyta) di Hutan Kecamata Mesjid Raya Kabupaten Aceh Besar Sebagai Media Pembelajaran Biologi. *Jurnal Biologi Education*, 10(1), 94-102. https://doi.org/10.32672/jbe.v10i1.4386.

Bawaihaty, N. I., & Hilwan, I. (2014). Keanekaragaman dan Peran Ekologi Bryophyta di Hutan Sesaot Lombok, Nusa Tenggara Barat. *Jurnal Silfikultur Tropika*, 5(1), 13-17.

Effendi, R., Salsabila, H., & Malik, A. (2018). Pemahaman Tentang Lingkungan Berkelanjutan. *Jurnal Modul*, 18(2), 75-82. https://doi.org/10.14710/mdl.18.2.2018.75-82.

Endang, T., Jumiati., & Pramesti, D. (2020). Inventarisasi Jenis-Jenis Lumut (*Bryophita*) di Kecamatan Batauga Kebupaten Buton Selatan. *Jurnal Biologi Tropis*, 20(2), 161-172. https://doi.org/10.29303/jbt.v20i2.1807.

Febriansah, R., Eni, S., & Arbaul, F. (2019). Identifikasi Keanekaragaman Marchantiophyta di Kawasan Air Terjun Parangkikis Pagerwojo Tulungagung. *Jurnal Biologi dan Pembelajarannya*, 6(2), 17-21. https://doi.org/10.29407/jbp.v6i2.14795.

Febrianti, G.N. (2015). *Identifikasi Tumbuhan Lumut (Bryophyta) di Lingkungan Universitas Jember serta Pemanfaatanya sebagai Buku Nonteks*. Skripsi. Universitas Jember, Jember. (Tidak diterbitkan).

Goffinet, B. (2008). *Bryophyte Biology*. Cambridge University Press. UK

Hugonnot, V., & Celle, J. (2012). Asexual Reproduction by Leaf Fragmentation in *Mnium stelleare* Hedw. *Journal of Bryology*, 34 (1), 67-70.

Karomah, S. D., Gurnita., & Ibrahim, Y. (2020). Identifikasi Jenis-Jenis Tumbuhan Lumut Hati (Marchantiophyta) Di Hutan Cagar Alam Situ Patenggang. *BIOSFER: J.Bio. & Pend.Bio*, 5(2), 21-25. https://doi.org/10.23969/biosfer.v5i2.3479.

Kirschner, R., Nebel, M., & T. Butterfass, T. (2010). Observations on fertile populations of *Lunularia cruciata* (L.) Dumort. ex Lindb. (Marchantiopsida: Lunulariaceae) in Germany. *Stuttgarter Beiträge zur Naturkunde A. Neue Serie* 3, 363–371.

Koponen, T., & Higuchi, M. (2020). Revision and Checklist of *Philonotis* (Bartramiaceae, Bryophyta) in Pakistan, With the Status of *P. trachyphylla* Dixon & Badhw. and note on *Mnium riparium* Mitt. (Mniaceae). *National Museum of Nature*, 46 (2), 55-64. https://doi.org/10.5735/085.057.0402.

Liannah, Kusumawari, N., Rochmah, F., Orsida, F., Mukhlisi, Ahmad, M.U., & Nadhifah, A. (2021). Bryophyte Diversity in Mountain Prau, Blumah Village, Central Java. *Jurnal Biodjati*, 6(1), 23-35. https://doi.org/10.15575/biodjati.v6i1.11693.

Lukitasari, M. (2016). *Mengenal Tumbuhan Lumut (Bryophyta) Deskripsi, Klasifikasi, Potensi dan Cara Mempelajarinya*. Magetan: CV. AE Media Grafika.

Lukitasari, M. (2018). *Mengenal Tumbuhan Lumut (Bryophyta): Deskripsi, Klasifikasi, Potensi dan Cara Mempelajarinya*. Magetan: CV. AE Media Grafika.

Lestari, R. W., & Ariyanti, N. S. (2017). *Bazzania* (Marchantiophyta: Lepidoziaceae) Di Taman Nasional Gunung Leuser (Sumatra). *Floribunda*. 5(7), 227-238.

Marom, K., Nasrulloh, S.Q., Zulaekhah, E., Isa, A.K., dan Firmansyah, M.A. (2017). Keanekaragaman Jenis Lumut (*Bryophyta*) di Sekitar Sumber Air Asin Sendang Jaka Tawa Banyurip Grobogan. Seminar Nasional Sains dan Enttrepreneurship IV (*Prosiding*). Universitas PGRI Semarang.

Moelong, L.J. (2017). *Metode Penelitian Klualitatif*. Bandung: PT. Remaja Rosdakarya.

Mulyani, E., Perwati, L. K. Dan Murningsih, M. (2015). Lumut Daun Epifit di Zona Tropik Kawasan Gunung Ungaran, Jawa Tengah. *Bioma: Berkala*

Ilmiah Biologi. 16(2), 76-82. https://doi.org/10.14710/bioma.16.2.76-82.

Nasuha, A., Sari, D., & Windarsih, G. (2021). Identifikasi Morfologi *Ceratodon* dan *Leucobryum* albidum di Kawassan Hutan Kota Serang, Banten. *Tropical Bioscience: Journale of Bilogical Science*, 1 (1), 11-20. https://doi.org/10.32678/tropicalbiosci.v1i1.4361.

Perwati, K. L., Rahadian, R., & Baskoro, K. (2015). Perbandingan Komposisi Tumbuhan Lumut Epifit pada Hutan Alam, Kebun Kopi dan Kebun Teh di Sepanjang Gradien Ketinggian Gunung Ungaran, Jawa Tengah. *Bioma: Berkala Ilmiah Biologi*, 17(2), 83-93. https://doi.org/10.14710/bioma.17.2.83-93.

Raihan, C., Nurasiah, & Zahara, N. (2018). Keanekaragaman Tumbuhan Lumut (Bryophyta) di Air Terjun Peucari Bueng Jantho Kabupaten Aceh Besar. Prosiding Seminar Nasional Biotik (*Prosiding*). Prodi Biologi FTK UIN Ar-Raniry.

Ristanto, R.H., Syahira, H.Q., Yuanisa, A.T., Amalia, A., Lianita, R., Azzahra, A., & Sigit, D.V. (2021). Mosses at the Bodogol Natural Conservation Education Center: Species, Diversity Indeks, and Evenness Indeks. *JPBIO (Jurnal Pendidikan Biologi)*, 6 (2), 220-230. https://doi.org/10.31932/jpbio.v6i2.1308.

Roziaty, E., Agustina, P., & Rohmah, S.N. (2019). Inventory of Epiphytic Moss in the Tree Trunk Zonation of Jumog Waterfall Ngargoyoso Tawangmangu Karanganyar Central Java, Indonesia. *Jurnal Ilmiah Biologi*, 7 (2), 73-79. https://doi.org/10.24252/bio.v7i2.6336.

Rusidi, Henri, dan Santi, R. (2021). Keanekaragaman Jenis Lumut (*Bryophyta*) di Bukit Nenek Taman Wisata Alam Gunung Permisan, Kabupaten Bangka Selatan. *Jurnal Biologi Udayana*, 25 (2), 137-146.

Pasaribu, N. 2013. Studi Pendahuluan Lumut di Lau Kawar, Kabupaten Karo. [Prosiding]. Semirata FMIPA Universitas Lampung. p.193-198

Putna S., dan Mezaka A. (2014). Distribution of Five Interesting Woodland Key Habitat Bryophyte Indicator Species in Latvia. *Acta Biol. Univ. Daugavp*, 14 (1), 67-74. https://www.researchgate.net/journal/Acta-Biologica-Universitatis-Daugavpiliensis-1407-8953.

Solihat, S. S., & Kurnia, M.F. (2021). Identifikasi Morfologi *Marchantia polymorpha* dan *Leucobryum glaucum* di Bojong Menteng, Kecamatan Cijeruk, Kabupaten Bogor, Jawa Barat. *Journal of Biological Science*, 1 (1), 29-38. https://doi.org/10.32678/tropicalbiosci.v1i1.4360.

Sopacua G., Tamaela K. A., Sopratu P., & Selehulano K. (2020). Inventarisasi Tumbuhan Lumut Di Kawasan Air Potang-Potang Negeri Itawaka Kabupaten Maluku Tengah. *Jurnal Ilmiah Wahana Pendidikan*, 6 (4), 611-618. https://doi.org/10.5281/zenodo.4297891.

Sundra, I.K. (2016). *Metode dan Tenik Analisis Flora dan Fauna Darat*. Biologi FMIPA Universitas Udayana. Denpasar.

Tomovic, G., Sabovljevic, M.S., Denchev, T.T., Denchev, C.M., Niketic, M., Boycheva, P., Ivanov, D., Sabanovic, E., Djordjevic, V., Kutmar, L., Stefanut, S., Pantovic, J., Grdovic, S., Kuzmanovic, N., Masic, E., & Lazarevic, P. (2021). New Records and Noteworthy Data of Plants, Algae and Fungi in SE Europe and adjacent Regions, 4. *Botanica Serbica*, 45 (1), 129-136. http://dx.doi.org/10.2298/BOTSERB2201125S.

Wati, T.K., Kiswardiana, B., & Sulistyarsi, A. (2016). Keanekaragaman Hayati Tanaman Lumut (Bryophyta) di Hutan Sekitar Waduk Kedung Brubus Kecamatan Keceng Kabupaten Madiun. *Jurnal Florea*, 3(1), 46. http://e-journal.unipma.ac.id/index.php/JF/article/view/787.

Wen, L. Y., & Huang S. (2017). *Marchantia* L. (Marchantiaceae-Marchantiophyta) in Taiwan. *Taiwania*, 62(1), 55–62.