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Epiphyte Mosses (Bryophytes) on Plants in Parking Areas along the Main Line of Brawijaya University

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Abstract. This research aimed to identify the various types of epiphytic moss in the parking areas along the main line of Brawijaya University and to identify the various types of the host plants. The methods were a selection of parking areas, exploration, and identification. The parking areas selected were off the street having a security guard and security post that requires identification. The election was also based on location along the main line, which was suspected to be more contaminated by air pollution. Exploration was done in the selected parking areas by observation of each tree found. Moss that was found growing attached to the tree was then collected. Notes taken when collecting included the name of the parking area, host plants, overgrown parts, collecting time and abiotic factors. Identification was done in the Taxonomy, Structure, and Plant Development Laboratory, Biology Department, Faculty of Mathematics and Natural Sciences, Brawijaya University. Identification was made using the identification book of Malesiana Bryophytes. The results showed that there were 14 epiphytic bryophytes of 17 genera from 20 species. A total of 19 species grew on tree trunks and one species on the root of the tree. Nine species of trees were covered with epiphytic bryophytes, both on the stem and roots. There were nine families of bryophytes that can be used as bio-indicators of air pollution found in the research location.

Keywords: bio-indicators, bryophytes, exploration, identification, parking area

INTRODUCTION

Bryophyte (moss) is one of the low-level plant groups. Bryophytes can act as air pollution bio-indicator agents. Habitat diversity, structural simplicity, totipotency and high metal accumulation capacity make bryophytes an ideal organism for pollution studies. Bryophytes are indicators that can be used to monitor air pollution because they easily to show a wide range of sensitivity, as well as symptoms caused by pollutants, more so than high plants. The decline in or lack of populations of the primarily epiphytic bryophytes is a phenomenon that can be caused by air pollution.[1]

Brawijaya University (UB) is one of the state universities in Malang, East Java. Brawijaya University has a campus of 2,203,948 m² with a total of 65,814 academicians.[2,3] A large number of academicians results in a large number of motor vehicles. Brawijaya University has parking space spread through 66 lots with a capacity of 9,421 motor vehicles.[4] A large number of motor vehicles and long-term use will undoubtedly affect air quality.[5] Air is an important factor for survival, but in this modern era with the development of transportation the quality of air has changed. Changes in air quality are caused by air pollution.[5] Air pollution has become one of the major threats for both human and environmental health.[1]

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Brawijaya University has shown concern for the air pollution problem. This awareness was realized through the Green Campus program at the 52nd Anniversary. However, that the program only focuses on high-level tree planting.[6] whereas low-grade plants such as bryophytes can also play a role in air pollution problems. The study of bryophytes at UB has not been previously done, even the herbarium data for bryophytes at UB is not available either in the Herbarium of Brawijaya University or the Herbarium Bogoriense (HBO). Therefore, this research is vital to identify the various types of epiphytic mosses on the plants in the parking area along the main line of Brawijaya University and the diversity of the overgrowth plant.

MATERIALS AND METHODS

This research was conducted during the dry season in August-December 2017. The location of this research was in the parking areas along the main line of Brawijaya University as well as the Taxonomy Laboratory, Structure and Development of Plants, Biology Department, Faculty of Mathematics and Natural Sciences, Brawijaya University Malang. The selected parking areas were off-street types with a guard system in the form of a security guard and security post requiring identification.[7] The selection of the parking areas was also based on the location being along the main line as it was suspected of having greater air pollution potential. The parking area along the main line not only gets pollution from parked vehicles but also pollution from vehicles just passing along the main line.

The study was conducted by exploration method.[8] Observations were made on each plant found in the study sites. When the moss was found attached to a plant, the plant was marked with a number then the attached moss was taken for collected. Moss was taken on plants with a height of 0-2 m. Noted at the time of collection were the name of the parking area, the host's name, the host plant's characteristics such as the type of bark, the moss-covered plant part, the collection time and the abiotic factors (temperature, humidity, and light intensity). Moss collection was done by cutting the moss colony with its substrate and then inserting it into the envelope. The specimen was then brought to the laboratory to be dried by opening the envelope. The equipment used during the collection were stationery, location map of parking areas, envelope, tweezers, camera and observation table.

Tools and materials for identification were two pointed tweezers, object glass, glass cover, stereo microscope, light microscope, two Petri dishes, white paper, beaker, label, dropper, water, liquid soap, stationary, cameras and identification books. As much as 30 mL of tap water mixed with soap placed in glass. It used to soak the moss sample. Soap serves to accelerate the water absorption and balance the water pressure. It was only used to restore fresh conditions on the moss to be identified. Individual samples of moss was removed with tweezers and soaked in soap solution for 1-2 minutes or until the moss re expanded to as fresh condition. Individual expanding mosses were placed in a clean petri dish and were observed under a stereomicroscope on the background of a blank sheet of white paper. A leaf of a bryophyte was removed with two tweezers and placed on the object glass. The object glass was filled with a drop of water and closed using a glass cover. Leaf blades were observed using a light microscope with 40x, 100x and 400x magnifications. [9] Important parts to consider for identification are gametophyte type (growth, branching, leaf tips, leaf base, cell types, *cancellina*, *amphigastria,* etc.) and sporophyte type (sporophyte form, peristome teeth, etc.). The observations were then photographed, and the required data recorded before samples were identified using the Biotrop fourth regional training course on biodiversity conservation of bryophytes and lichens,[10] Guide of the liverworts and hornworts of Java, [11] The Philippine Journal of Science Volume 68,[12] A handbook of Malesian mosses volumes I [13] (Eddy, 1988) and II[14].

The literature study was conducted by searching and reading the individual moss-related journals that were identified for a fuller morphological description as well as presenting the names of the genera and type inventors. Data analysis was done by a descriptive method. The results of data analysis were presented in the form of description and table. Descriptions of the mosses were the level of clan or type, while in host plants only type of bark. The genera and species types in each tribe are then also presented in tabular form.

RESULTS AND DISCUSSION

Brawijaya University is located at coordinate point 112° 36'45.88"E 7° 57'20.00"S with an altitude of 492 m.[15] Brawijaya University has 66 parking areas.[4] The selection of parking areas as sampling locations was made on August 25, 2017, with the temperature 34°C, 0 mm rainfall.[16] Low humidity and high light intensity. The selection was based on the location of the area along the main line as it has greater air pollution potential than parking areas at other locations. The selection was also based on the presence or absence of plants overgrown with epiphytic moss. The election results showed that there were 20 parking areas along the main line, Fig. 1.

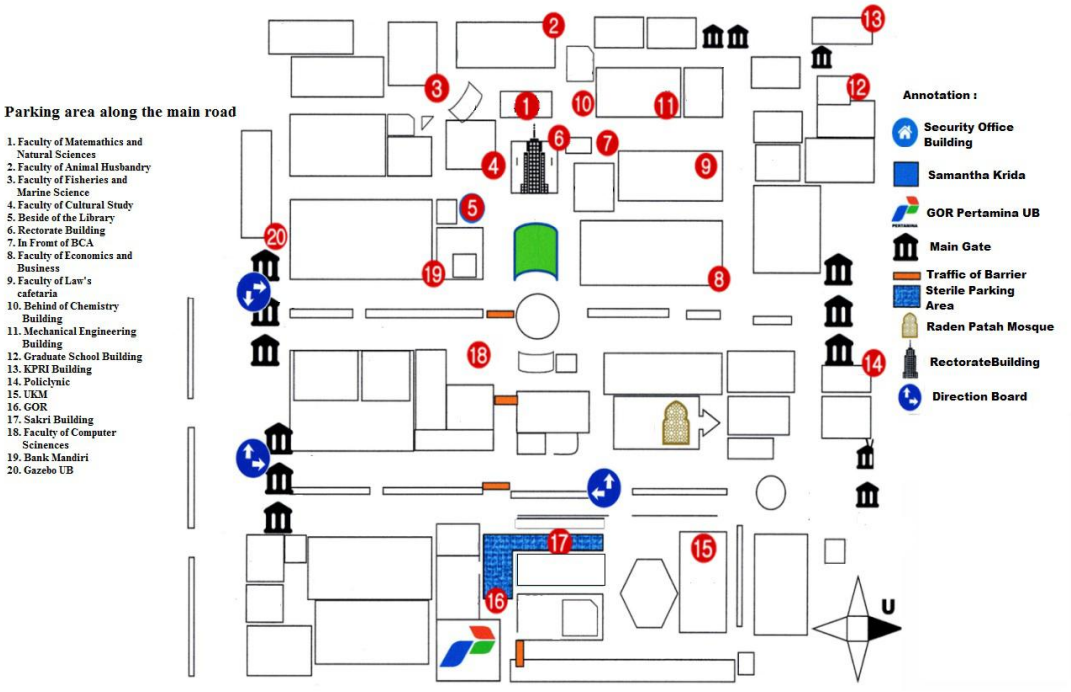


FIGURE 1. Map of parking location in Brawijaya University.

The exploration showed that there were 103 trees in the parking area along the main line of Brawijaya University overgrown with epiphytic moss. The trees consisted of six tribes of nine genera and nine species, Table 1. Five tribes of plants were angiosperms while *Pinaceae* is a gymnosperm. Angiosperms are plants that have flowers and produce seeds in the ovaries (fruit), whereas gymnosperms are plants that have open seeds (not in the ovaries) and ordinarily seeds are arranged in conical form.[17] Angiosperms were potentially more overgrown with moss because the number of these plants at UB was more significant than gymnosperms. This may be because angiosperms are more modern than gymnosperms, having a more varied reproduction apparatus that allows the process of pollination to occur in various ways. Thus, angiosperms can be found in various places.[18]

TABLE 1. Various types of host plants in the parking area along the main line of Brawijaya University

Family	Genera	Species	Total
Angiospermae			
Fabaceae	*Pterocarpus*	*P. indicus*	12
	Albizia	*Albizia saman*	12
	Erythrina	*Erythrina* sp.	1
Meliaceae	*Swietenia*	*S. mahagoni*	7
Arecaceae	*Elaeis*	*E. guineensis* J.	52
	Roystonea	*Roystonea regia*	5
Poaceae	*Phoenix*	*Phoenix* sp.	1
Elaeocarpaceae	*Elaeocarpus*	*Elaeocarpus* sp.	11
Gymnospermae			
Pinaceae	*Pinus*	*Pinus merkusii*	2
6 Families	**9 genuses**	**9 species**	**103**

Based on the first table, it appears that the tree species with the largest number found was oil palm (*Elaeis guineensis* J.) while the least was dadap merah (*Erythrina* sp.) and ornamental date (*Phoenix* sp.). As many as 52 oil palm trees were found, while only one tree each of dadap merah and ornamental date was found. Arecaceae tribe, especially oil palm, was a host plant as many were overgrown with moss. This may be because oil palm was intentionally planted along the edge of the main lane and the plant has become iconic on the main route. Brawijaya University has quite a lot of palm trees, there were 605 trees[19]; therefore, oil palm was potentially more common than other crops.

Sampling of moss was done on September 15, 2017 with abiotic factors being temperature of 32ºC, 0 mm rainfall,[16] high light intensity and low humidity. The collection of 103 trees scattered in 20 parking areas included 114 samples of moss. The identification results showed that from all of the samples there were 14 tribes of 17 genera and 20 species of epiphytic bryophytes, Table 2. The tribe most commonly found was Calymperaceae, while the type that was most widely found was *Octoblepharum albidum*.

The number of Calymperaceae tribes found were due to variations of habitat (both low and high humidity) the tribe members can occupy. Calymperaceae also has a variety of ways of multiplication. This tribe can multiply itself with the spores produced in the sporophyte phase, as well as vegetatively using gemmae located at the end of the leaf repetition. When gemmae come loose from the leaves and fall in the right environment they will grow into a new individual. *Calymperes* also have clumped growth types just as the Syrropodon genera. This increases the potential of the moss to retain water from the environment so that it can survive when there is drought.[20] Members of the Calymperaceae tribe are also known to be capable of living in and tolerant to relatively high temperatures and have better drought resistance than other types of moss.[21] This is supported by Eddy [14] as well as Ellis and Tan[21] as reported by Windadri [22], who stated that there are members of the Calymperaceae tribe that are able to grow both in open and shady environments on various substrates such as trees (from roots to branches) at an altitude of up to 500 m.

The total sample obtained showed that there was only one moss colony, which had gametophyte and sporophyte phases, i.e., *Octoblepharum albidum* type. This type of moss was found in 20 samples, the highest number; however, only one sample was found to have a sporophyte phase. This happened because the reproductive cycle of *O. albidum* is very short. The study was conducted during the dry season, while *O. albidum* will produce spores (during the sporophyte phase) in the first two months of the rainy season.[23] Previous study stated that the development of archegonia in *O. albidum* occurs over a very short time. Fertilization generally occurs at one to two months after the emergence of archegonia. This cycle is different from that in other mosses in which, generally, fertilization will occur several months after the emergence of antheridium and archegonia, for example in *Sematophyllum subpinnatum* (Brid.) Britt.[23]

The presence of *Octoblepharum albidum* in large quantities may also be due to high survival. Mirsa and Tandon.[24] stated that this type of moss was able to survive in air polluted habitats. This was because the moss can absorb heavy metals such as Pb, Cu, Co, Cr and Ni, so this moss is also often used as a bio-indicator of air pollution. Saat et al.[25] also stated that *Octoblepharum* sp. can be used as a bio-monitor of air pollution in the long-term because of the ability to absorb heavy metals associated with motor vehicle fuel emissions.

TABLE 2. Various types and numbers of epiphytic Bryophytes

Family	Genera	Species	Total
Calymperaceae	*Calymperes*	*C. tenerum*	8
		C. afzelii	11
		C. motleyi	1
		C. molluccense	2
Lejeuneaceae	*Syzygiella*	*S. subintegerrima*	1
Pterobryaceae	*Pterobryopsis*	*Pterobryopsis* sp.	5
Cladoporaceae	*Cladopodium*	*Cladopodium* sp.	6
Sematophyllaceae	*Meiothecium*	*M. attenuatum*	9
Frullaniaceae	*Frullania*	*F. subgen*	8
Octoblepharaceae	*Octoblepharum*	*O. albidum*	20
Plagiochillaceae	*Plagiochilion*	*P. braunianum*	7
Stereophyllaceae	*Stereophyllum*	*Stereophyllum* sp.	3
Neckeraceae	*Homaliodendron*	*Homaliodendron* sp.	3
Jungermanniaceae	*Tuyamaella*	*T. angulistipa*	5
	Nardia	*N. scalaris*	8
Myuriaceae	*Piloecium*	*Piloecium* sp.	1
Hypnaceae	*Ectropothecium*	*Ectropothecium* sp.	2
Hookeriaceae	*Schizomitrium*	*Schizomitrium* sp.	1
	Sclerohypnum	*Sclerohypnum* sp.	1
	Chaetomitrium	*Chaetomitrium* sp.	3
Not Identified			9
14	**17**	**20**	**114**

There were unidentified samples because the sample was still in the protonemal phase. A more detailed description of each of the identified species is as follows:

1a. Acrocarps, have chlorocysts, whether or not leucocysts..…….……..…….…….…….. 2
1b. Pleurocarps, distinguished or not distinguished upon lobe, lobule, amphigastria……..……..….. 3
2a. Chlorocysts present, linear cell, excurrent, cancellina present……..…… **Octoblepharaceae**
2b. Without chlorocysts, rounded obtuse, mucronate, excurrent, with cancellina……..…..… **Calymperaceae**
3a. Distinguished upon lobe, lobule and amphigastria.…..…….. 4
3b. Not distinguished upon lobe, lobule and amphigastria……..… 5
4a. Lobule forming a sac…….……..... **Frullaniaceae**
4b. Lobule not forming a sac ……...……..…..……..... 6
5a. Hexagon or hexagonal cells ……...…….. **Jungermanniaceae**
5b. Isodiametric cells ……..……..... **Plagiochillaceae**
6a. Without costa, without papilla ……..…… 7
6b. With or without costa, with or without papilla ……...…….. 8
7a. Hexagon cells, without alar cells, linear cells, oblong, complanate ….…..……..... 9
7b. Rhomboid cell, linear, with alar cells, with or without limbidium …….……..... 10
8a. Without costa or with single or double costa …… **Hookeriaceae**
8b. With single or double costa ……...…….. 11
9a. Oblong, hexagon cells, leaves opposite, smooth surface ……..… **Lejeuneaceae**
9b. Complanate, linier cells, little papilla ……..…..... **Myuriaceae**
10a. Limbidium present, sharply-accuminate ……...…… **Sematophyllaceae**
10b. Without limbidium, with or without alar cells ……..…… 12
11a. Single costa, with or without alar cells, flat or jagged edges ..……..... 13
11b. Double costa, broad, little papilla …….. **Hypnaceae**
12a. Alar cells present, elongated rhomboid cells …….. **Stereophyllaceae**
12b. Without alar cells, rhomboid cells ……...… **Neckeraceae**
13a. Alar cells present, flat edges, linear cells……..…. **Pterobryaceae**
13b. Without alar cells, jagged edges, linear cells, rhomboid, rhomboid-linear …….…... **Cladoporaceae**

Octoblepharaceae

The tribe of the moss was composed of only one genus, *Octoblepharum*, and several species. The main character possessed was looking whitish or grayish when dry. This is due to several layers of leucocytes. The species diversity of this tribe can be found abundantly in the tropics of America. There are about five different species that can be found in the region; however, only one species was found in the Malesia region, that was *Octoblepharum albidum*.[14]

***Octoblepharum albidum Hedw., Sp. Musc. 50* (1801)**

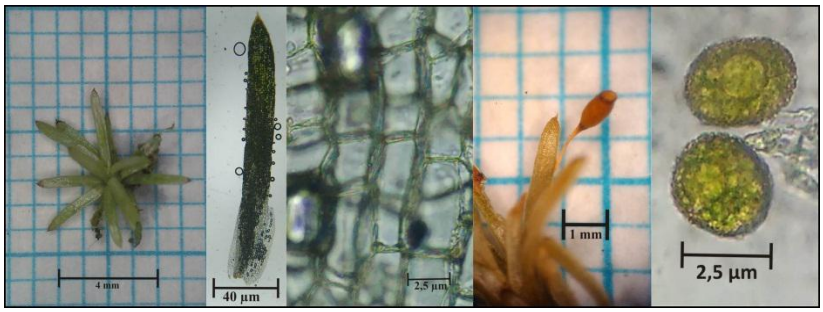
Holotype:

E. L. Ekman (1917) Cuba. S S-Bryophytes B101911

L.G. Cooper Nigeria. E E E00428140

Individuals grow upright to approximately 1.2 cm. Leaves were polytrichus, curved out, shiny, whitish when dry, jagged edges, squared cells, without papilla, excurrent tip. One costa, very thin, only observed when cutting across. There is a thickening of the leaf edge, narrow leaf edge, jagged. There is cancellina, Fig, 2.

Habitat and spread: many epiphytes found in oil palm, *Pinus,* and Genitri plants. Distribution: abundant in Malesia area with altitude 0-1600 m.[14]



(a) (b) (c) (d) (e)

FIGURE 2. Octoblepharum albidum (a) gametophyte; (b) leaf (M 40x); (c) cell type (M 400x); (d) sporophyte and (e) spores (M 400x).

Calymperaceae

Individuals grow upright, rarely grow creepers except for the *Mitthyridium*. Consists of many clans. Leaf types vary widely, also influenced by the gemmae on the tip of the leaf. This tribe is widespread in both the tropics and the subtropics. Almost all members of this tribe are epiphytic moss types, epilithic or terrestrial types are rarely found[14]. One genus found in this study was *Calymperes* with four different types.

***Calymperes tenerum C. Müll.* in Linnaea 37:174 (1872)**

Synonyms:

C. pachyneurum C. Müll. in J. Mus. Godeffroy 3(6):65 (1874).

C. pandani C. Müll. in Bot. Jb. 5:87 (1875).

C. kaernbachii Broth. In Bot. Jb. 17:477 (1893).

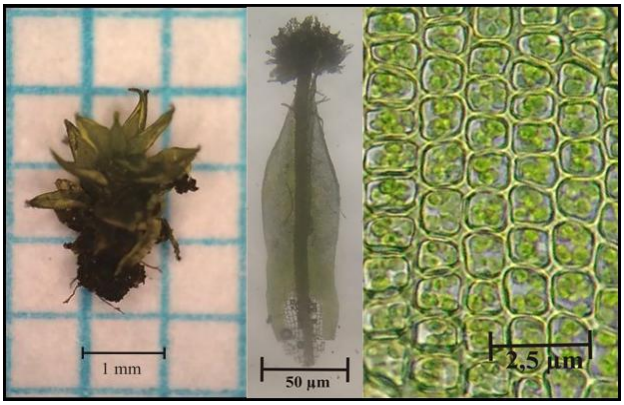
C. bataviense Fleisch., Musci Fl. Buitenzorg 1:276 (1904) fid. Reese et al., 1986.

C. daruense Bartr. in Farlowia 1:43 (1943).

Holotype: L. J. Brass (1936) Papua New Guinea. Harvard University FHbarcode00060235

Individuals are tiny, approximately 3 mm. Leaves politrichus, squared cells, without thickening of the leaf edge (limbidium), flat edges, papilla not visible, gemmae present. Single costa, excurrent. Cancellina present, seven rows, large cells, Fig. 3.

Habitat and distribution: found epiphytes on angsana kembang, oil palm, palem raja and trembesi trees. Eddy[14] states that this species can easily be found in tropical Asia, often in the Malesia region, especially in locations near the sea but with an altitude of 1500 m.



(a) (b) (c)

FIGURE 3. *Calymperes tenerum* (a) individual; (b) leaf (M 40x) and (c) quadrate cell type (M 400x).

***Calymperes molluccense Schweger., Sp. Musc*. Suppl. 1(2):334 (1816)**

Synonyms:

C. incurvatum C. Müll. in J. Mus. Godeffroy 3 (6):64 (1874).

C. kurzianum Hampe ex C. Müll. in Flora 61:82 (1878).

C. chamaeleonteum C. Müll. in Bot. Jb. 5:86 (1883).

C. brachyphyllum C. Müll. ex Besch. in Annls Sci. Nat. Bot., sér. 8 (1): 78 (1896)

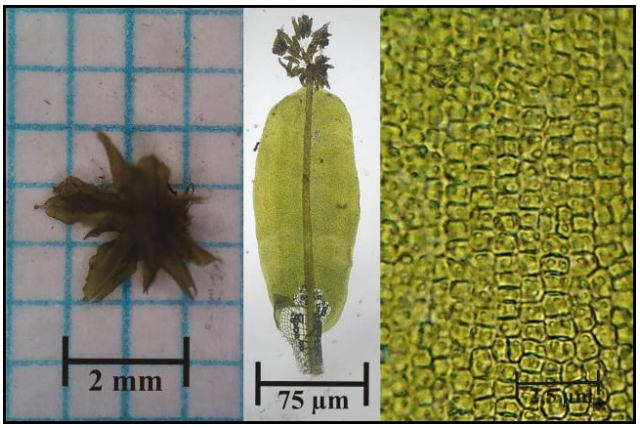
C. platycinclis Besch. in Annls Sci. Nat. Bot., sér 8 (1):299 (1896)

C. contractulum Besch. in Fleisch., Musci Fl. Buitenzorg 1:272 (1904)

Holotype: Arthur Francis George Kerr; b.1877; d.1942; Kerr (1930) Thailand. NHMUK BOT BM000518147

Plants are small, approximately 3 mm. Leaves are politrichus, short squared cells, no cancellina, no alar cells, no limbidium, there is a teniole so that the edges are jagged, there is a costa (rib) and there are gemmae with a rounded-obtuse tip, Fig. 4.

Habitat and spread: found on the trunk of the oil palm tree. Widespread in the tropics of Asia and Polynesia, many also in the Malesia region and also rocks with a elevation of 300 m. [14]



(a) (b) (c)

FIGURE 4. *Calymperes molluccense* (a) individual; (b) leaf (M 40x) and (c) quadrate cell type (M 400x)

***Calymperes afzelii Sw*. in Jb. Gewachsk. 1:3 (1818)**

Synonyms:

C. vriesii Besch. In Annls Sci. Nat. Bot., Sér. 8(1):268, 307 (1896).

C. javanicum Fleisch., Musci Fl. Buitenzorg 1:260 (1904).

Holotype:

Per Karl Hjalmar Dusén; b.1855; d.1926; Dusén (1905) Cameroon.

Thomas Robertson Sim; b.1856; d.1938; Sim (1920). NHMUK BOT BM000575032

Georges Foreau; b.1882; d.1967; Foreau (1929) India. NHMUK BOT BM000518347

Individuals are large, approximately 1.5 cm. The leaves are smooth to shrink when dry, limbidium is only visible when wet, short squared cells, jagged edges, with gemmae present. Single costa, mucronate tip. Cancellina is very large, Fig. 5.

Habitat and distribution: this species found epiphytes on the oil palm rod at the study site. Widespread in Malesia but rarely found widespread in the bark, logs, moist rocks at an altitude < 100 m.[14]

(a) (b) (c)

FIGURE 5. *Calymperes afzelii* (a) individual; (b) leaf (M 40x) and (c) quadrate cell type (M 400x).

***Calymperes motleyi* Mitt. In Dozy and Molk., Bryol. Javanica 1:48 (1856)**

Synonym:

C. chamissonis Besch. In Annls Sci. Nat. Bot., sér. 8(1):280 (1895)

Holotype:

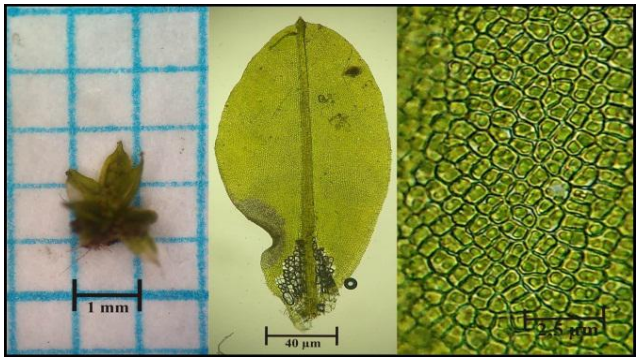
Quayle, E.H. (1922) French Polynesia. BPBM BISH 84401

E. H. Quayle (1922) French Polynesia. Harvard University FH barcode-00060249

E. H. Quayle (1922) French Polynesia. Harvard University FH barcode-00060250

Small individuals, approximately 2 mm. Leaves are politrichus, small squared cells and short squares, wider ends than the base (broadly mucronate), serrated edges, there is little cancellina, single costa, Fig. 6.

Habitat and spread: only found growing in the stem of the oil palm. Widespread in Polynesia, Malesia and Northern Australia, but rarely found in trees at low altitudes and open forest.[14]



(a) (b) (c)

FIGURE 6. *Calymperes motleyi* (a) individual; (b) leaf (M 100x) and (c) quadrat cell type (M 400x).

Moss habitats are generally in humid places. Humidity can be interpreted as high water content in a place. Moss needs a humid place for several reasons, one of which is that male gametes (sperm from antheridium) require water outside their bodies as a medium to swim to fertilize female gametes.[26] Another case is high-level plants that can fertilize by dropping stamens on the pistil through a pollen tube.[27] The simplicity of the structure of bryophytes also results in the absence of vascular tissue, which is usually used for transporting water. Bryophytes have no real roots capable of extracting water from soil particles. Therefore, bryophytes require direct water.[26]

The humid environment and the availability of water are closely related to the weather conditions in which bryophytes grow. Humidity will increase when the rainy season arrives. High humidity will be experienced by tropical countries for approximately six months, but subtropical countries only experienced about three months, i.e., in early winter and early spring. Environmental conditions like this require bryophytes to have a habitat that is able to make these plants live all the time. One possible habitat is on tree trunks.

The bark on tree trunks (pepagan) is divided into several types. Leather that contains gaps can keep moisture longer. These gaps can withstand the spores that have fallen and become the attachment of moss rhizomes, hence finer tree bark has fewer mosses than rough trees.[29] Narrow and steep gaps on tree trunks also result in not many high-level plants being able to utilize the gap as a habitat.

The results show that of the nine host plants found; oil palm was the most overgrown plant for various types of moss, Table 3. The mosses found were attached to the bark of the oil palm. The oil palm itself has a stem that is hard to see. This is because the leaves of the stem cover the surface of the stem, so the bark referred to in this study is the residual of old leaves that are still attached and cover the entire surface of the stem.

The abundance of epiphytic mosses on oil palms is thought to be due to the remaining inherent leaves that provide a unique habitat. The remains of the midrib form a pouch, so it can hold the humus and keep moisture longer. The relatively small surface area of the midrib sac makes the low-level plant capable of occupying the area as a microhabitat.[30]

TABLE 3. Various types of host plants

Bryophytes	Host Plants								
	A	B	C	D	E	F	G	H	I
Calymperaceae									
Calymperes tenerum	+	-	+	+	-	-	-	-	+
Calymperes afzelii	-	-	+	-	-	-	-	-	-
Calymperes motleyi	-	-	+	-	-	-	-	-	-
Calymperes molluccense	-	-	+	-	-	-	-	-	-
Lejeuneaceae									
Syzygiella subintegerrima	-	+	-	-	-	-	-	-	-
Pterobryaceae									
Pterobryopsis sp.	+	+	-	-	-	-	-	+	+
Cladoporaceae									
Cladopodium sp.	+	-	+	+	-	+	-	+	-
Sematophyllaceae									
Meiothecium attenuatum	+	-	+	+	-	-	-	+	-
Frullaniaceae									
Frullania subgen	-	-	+	+	-	-	-	+	+
Octoblepharaceae									
Octoblepharum albidum	-	-	+	-	+	-	-	+	-
Plagiochiliaceae									
Plagiochilion braunianum	+	+	+	-	-	-	-	+	-
Stereophyllaceae									
Stereophyllum sp.	-	-	+	+	-	-	-	+	-
Neckeraceae									
Homaliodendron sp.	-	-	-	-	-	-	-	+	+
Jungermanniaceae									
Tuyamaella angulistipa	+	-	+	+	-	-	-	-	+
Nardia scalaris	+	+	-	-	-	+	+	+	-
Myuriaceae									
Piloechium sp.	-	-	-	-	-	-	-	-	+
Hypnaceae									
Ectropothecium sp.	-	-	+	-	-	-	-	-	+
Hookeriaceae									
Schizomitrium sp.	-	-	+	-	-	-	-	-	-
Sclerohypnum sp.	-	+	-	-	-	-	-	-	-
Chaetomitrium sp.	-	-	+	-	-	-	-	-	+

Information :

Host plants: A : Pterocarpus indicus (Angsana Kembang)

B : *Swietenia mahagoni* (Mahoni)

C : *Elaeis guineensis* J. (Kelapa Sawit)

D : *Roystonea regia* (Palem Raja)

E : *Pinus merkusii* (Pinus)

F : *Erythrina* sp. (Dadap Merah)

G : *Phoenix* sp. (Kurma Hias)

H : *Elaeocarpus* sp. (Genitri)

I : *Albizia saman* (Trembesi)

\+ : found

\- : not found

Moss in the parking area along the main line of UB, suspected of air pollution, were from as many as 14 tribes, 17 genera, and 20 species. The study of the literature showed that of the entire moss samples, there were nine tribes that have roles as bioindicators of air pollution. The nine tribes were *Calymperaceae, Lejeuneaceae, Hypnaceae, Stereophyllaceae, Sematophyllaceae, Octoblepharaceae*[26], *Frullaniaceae, Jungermanniaceae*[30,31] and *Neckeraceae*[29] Table 4.

TABLE 4. Some moss family absorbs heavy metals

Family	Heavy metal absorbed											References
	SO_2	Cr	As	Zn	Fe	Th	U	Ni	Cd	Pb	Cu	
Calymperaceae	+											
Lejeuneaceae	+											
Hypnaceae	+											31
Stereophyllaceae	+											
Sematophyllaceae	+											
Octoblepharaceae	+	+	+	+	+	+	+					24
Frullaniaceae		+		+				+	+	+	+	30,31, 33
Jungermanniaceae		+		+				+	+	+	+	
Neckeraceae	+											30

SUMMARY

The results of data collection at the study sites showed that there were 14 epiphytic mosses of 17 genera from 20 species.A total of 19 species grew on a substrate in the form of tree trunks and one species at the root of the tree. A total of nine species of trees were overgrown with epiphytic moss on the stem and root. There were nine tribes of moss that can act as bio-indicators of air pollution found growing at research locations.

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