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Diversidade do musgo na Malásia: uma revisão da literatura

Moss diversity in Malesia: a literature review

Diversidad de musgo en Malesia: una revisión de literature

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Risjunardi Damanik
ORCID: https://orcid.org/0000-0003-4860-7437
Biology Education Study Program, Universitas Simalungun, Indonésia
Email: risjunardidamanik@yahoo.com

Resumo

Este artigo tem o objetivo de resumir a literatura sobre o tema da distribuição de musgos da Malásia, que está intimamente relacionada à floresta tropical. Esta diversidade e distribuição de musgos é uma preocupação importante devido ao aumento da taxa de destruição de florestas tropicais em toda a região. Usando o método de revisão da literatura, o autor resume a ampla distribuição geográfica dos musgos, cobrindo as regiões tropicais da Ásia, Pacífico e Austrália. Alguns tipos de musgos não se espalham para o oeste através da linha Wallace. Também se fez uma revisão específica sobre a diversidade de musgos na região de Melasia. Assim, esta revisão inclui uma breve introdução aos musgos e depois se concentra nos seguintes tópicos; as características dos musgos; desenvolvimento de plantas de musgo; classificação de plantas de musgo; benefícios das plantas e diversidade de musgos na região da Malásia.

Palavras-chave: Diversidade de hepáticas; Malásia; Musgos.

Abstract

This article has the objective to overview literature on the topic of the distribution of Malesia mosses which is closely related to tropical forest. This diversity and distribution is an important concern because of the increasing rate of destruction of tropical forests throughout region. Using theoretical literature method, the author summarizes mosses' wide geographical distribution covering the tropical regions of Asia, the Pacific and Australia. Some types of liverworts do not spread west across the Wallace line. A review of liverworts literature has been conducted but a review specifically on the moss diversity in Melasia region is limited. Thus, this review includes a brief introduction to mosses and then focuses on the following

topics; the characteristics of mosses; development of moss plants; classification of moss plants; benefits of moss plants and moss diversity in the Malesia region.

Keywords: Liverworts diversity; Malesia region; Moss.

Resumen

Este artículo intenta hacer un resumen de la literatura sobre el tema de la distribución de los musgos de Malesia que está estrechamente relacionado con los bosques tropicales. Esta diversidad y distribución de los musgos de Malesia es una preocupación importante debido a la creciente tasa de destrucción de los bosques tropicales en toda la región de Malesia. Utilizando el método de la literatura teórica, el autor resume la amplia distribución geográfica de los musgos que cubre las regiones tropicales de Asia, el Pacífico y Australia. Algunos tipos de hígado no se extienden hacia el oeste a través de la línea Wallace. Se realizó una revisión de la literatura sobre el hígado, pero una revisión específica sobre la diversidad de musgos en la región de Melasia es limitada. Por lo tanto, esta revisión incluye una breve introducción a los musgos y luego se centra en los siguientes temas; las características de los musgos; desarrollo de plantas de musgo; clasificación de plantas de musgo; beneficios de las plantas de musgo y la diversidad de musgo en la región de Malesia.

Palabras clave: Diversidad de hepaticas; Región de Malesia; Musgos.

1. Introduction

Moss (Bryophyta) is a division of plants that live on land, which are generally green and small in size (cannot be seen with the help of lenses), and the largest size of mosses is less than 50 cm. These mosses live on rocks, wood, trees and land (Ariyanti, 2008). That Bryophyta has plastid cells that can produce chlorophyll, so it can make its own food and is autotrophic. Moss belongs to the kingdom plantae which includes all multicellular organisms and has differentiated, eukaryotic, and cell walls have cellulose (Gradstein, 2005). Organisms that are included in this plantae are almost entirely autotrophic (making their own food) with the help of sunlight during photosynthesis.

Distribution of Malesia Mosses is related to tectonic plates in the Malesia region which influences the origin and migration of Malesia mosses (John, 1995). Despite having great distances, the distribution pattern of these mosses remains an important explanation for local plant distribution patterns. Climate and changes in vegetation in Malesia are two important factors that contribute to the pattern of moss distribution in that region (Tan, B. C.,

1998)

Research on the relationship of geographic distribution of mosses with the first Wallace line was carried out on liverworts (Marchantiopsida) and the results showed this line was also quite instrumental in limiting the spread of liverworts; some types of liverworts did not cross these lines (Nunik, S. A., & Gradstein, S. R., 2007). In addition to discussing the effectiveness of the Wallace line as a barrier to the debate over organisms whose spread is carried out by the wind, especially liverworts, it is also important to compare the distribution of mosses based on altitude and geographic distribution. Using theoretical literature method, the author summarizes mosses' wide geographical distribution covering the tropical regions of Asia, the Pacific and Australia.

2. Methodology

This paper employed a literature review from books, scholarly articles, and any other sources relevant to a particular issue of the diversity of liverworts in Melasia. This method is used to provide a description, recap and overview of key sources (Fink, 2019). This is also to look at the corpus of theory regarding to an issue which also include articles published from researcher in the field, Tan B.C. from the period of 1993 to 2006. The theoretical literature review helps to establish what theories already exist and is often is used to help establish a lack of appropriate theories or reveal that current theories are inadequate for explaining new or emerging research topic.

3. Results and Discussion

The characteristics of mosses (*Bryophyta*)

Moss plants have several characteristics, including the following: (1) Small in size and rarely reach 15 cm; (2). the shape is flat like a ribbon, and those are like stems with small leaves; (3). the cells that make up the body have cell walls composed of cellulose

The stems and leaves have a different arrangement, namely: (1) A layer of skin cells, some of which form the rhoid epidermis, looks like a thread that functions as a root and absorbs food from water and mineral salts; (2). The inner skin layer is composed of cortex, the central cylinder consisting of supporting cells or elongated parenchyma, not containing xylem and phloem; (3). Central cylinder, consisting of parenchyma cells that are useful for

transporting water and mineral salts; (4). Growth in moss is lengthwise; (5). The composition of *gametangium (archegonium or anteredium*) has a unique arrangement, which is often found in ferns (*pteridophyta*), especially *aregonium*. *Arkegonium* is a female gamete that is shaped like a bottle and contains ovum cells, while *anteredium* is a male gamete that is spherical in shape and contains spermatozoid cells; (6). The leaves are as thick as one layer of cells, except for the mother's leaf bone which is more than one layer. Small leaf cells, containing chloroplasts that are arranged like a net and are narrow and elongated

Sporophyte (*sporogonium*) consists of: (1). Seta or tank; (2). *Vaginula*, which is the leg covered by an *archegonium* wall; (3). *Apofisis*, which is the tip of a seta or dilated tank, is a transition between the seta and the spore box; (4). *Caliptra* or hood, which comes from the upper *archegonium* wall and will become a spore box hood; (5). *Kolumela*, a network that does not take part in the formation of spores; (6). The reproductive system is *metagenesis*, namely the alternation of sexual reproduction (*gametophyte*) and asexual (*sporophyte*). Sexual reproduction forms male and female gametes in *gametophytes*, while asexual reproduction with haploid spores is formed in *sporophytes*.

Development of Moss Plants (*Bryophyta*)

The life cycle of mosses is *metagenesis*, because it alternates between sexual and asexual reproduction. Initially sporophytes produce spores that will become *protonemes*, from this protonema gametophytes are formed. This generation of gametophyte has a chromosome cell called haploid (n) and this gametophyte produces *gametangium* (reproductive organs) called *anteredium* in males and *archegonium* in females. *Gametangium* is protected by a special leaf (bract). *Anteredium* is round and produces sperm flagella (anterezoid and spermatozoid), while *archegonium* is shaped like a bottle that has a wide section called the stomach, and there is a narrow section called the neck.

Fertilization of eggs by *anterzoid* produces zygotes with two chromosome cells or called diploid (2n). This zygote is the beginning of sporophyte again. Then the zygote divides into an adult sporophyte which has legs to attach to gametophyte, seta, and capsules at the edges. This capsule is where spores are produced through phases in meiosis. After the spores cook and are removed from the capsule, the moss life cycle repeats again from the start.

Classification of Moss Plants (*Bryophyta*)

Broadly speaking, the types of mosses are divided into 3, namely: liverworts (*Hepaticeae*), leaf lichens (*Musci*), hornworts (*Anthocerotaceae*) (Shaw, A. J., & Goffinet, B, 2000).

a. Moss Heart (*Hepaticeae*)

As the name implies, this moss can be observed directly with the eye, this moss has a distinctive shape that is a curve that resembles the shape of the heart and is also divided into two lobes, just like the liver. This moss grows and sticks to rocks, soil, tree leaves in the tropics and walls in old, humid buildings. The liverwort as it also already known can photosynthesize for its own food (autotroph). Its body structure includes roots, stems and leaves. Liverworts are divided into two groups based on the shape of the talus, namely liverworts and leafy liverworts. The genitals are located in the dorsal (rear) talus of the type located in the terminal (tip) part.

Liverworts breed generously with *oogamy*, and with vegetative fragmentation, shoots, and buds. Inside the *spongaria* there are cells in the form of rolls and are called *elatera*, this *elatera* will be released when the capsule is open, and so it will help emit spores. These mosses also reproduce asexually by using cells called *gemma*, which are bowl shaped and are located on the surface of sporophytes. Examples of these mosses are *Marchantia polymorpha* and *Porella*.

b. Moss Leaves (*Musci*)

True lichens or lichens are lichens that we often encounter because their living spaces are more open than other lichens, the shape is more interesting True lichens are different from liverworts, which are in terms of their silts growing on all sides of the main axis or in other words, the leaves come from the center of the moss (radial symmetry).

These leaves have ribs in the middle and the ribs are arranged on stems by following a spiral line, the length can vary from one part to one inch and find one leg. In the middle rib it contains elongated cells; its function is to transport water and nutrients. True moss has no roots. Like peat moss and swamp moss, the leaves are unique because they have a small cell

network and separate large dead cells as well as having the ability to suck water that is normal. This is why this moss can survive in the swamp. The gametophyte has relatively small male and female genitals; fertilization is carried out by spermatozoid which moves actively with its flagella, if there is water the spermatozoid will swim towards the ovum. Then the result of fertilization becomes sporophyte, which when the sporophyte is ripe has a suction leg and a long stalk, also a typical capsule. Examples of these mosses are *Polytricum juniperinum*, *Furaria*, *Pogonatum cirratum*, *Aerobrysis longissima*, and peat moss or Sphagnum.

c. Hornworts (*Anthocerotaceae*)

The body of the hornwort resembles the liverwort, which is like a *thallus*, but its sporophyte is an elongated capsule that grows like the horn of a gametophyte. The way of breeding is the same as liverworts, which are generative breeding by forming *anteridium* and *archhegonium* which are collected on the upper side of the talus. The cell has only one chloroplast, this chloroplast is bigger and bigger than most mosses. Hornworts are found on the banks of rivers and lakes, along ditches, alongside wet and damp roads. One example of hornworts is *Anthoceros Laevis.*

Benefits of Moss Plants (*Bryophyta*)

Moss has benefits to humans, such as *Marchantia polymorpha*, this moss is included in the classification of liverworts, and as the name suggests it can be used as a treatment for hepatitis (infection of the liver) (Alamgir, 2007). Types of peat moss such as Sphagnum which are included in the classification of leaf moss can be used as a sanitary pad or cotton substitute. In the environment, mosses have a role as a provider of oxygen, water storage. Moss can store water that is caught between the leaves and the stem because the cells are like *rozoid* and parenchyma cells that can absorb water and mineral salts and are like a sponge. After the water is absorbed as in the liverwort that absorbs water in the place it grows, as in fallen trees, it will make the soil dry, and protect the moss from drying out too. With its ability to absorb water, it will also create a natural environment for seedbed nurseries for woody flower plants, herbs, and conifer plants. Moss also serves as an absorbent of pollution found in the environment. Moss can also add to the aesthetics of an area that is widely grown. And also contribute to the modification of the natural surroundings. Another role of

Bryophyta is to slow down the erosion process, because the water retention capacity is better than dead leaves, thus slowing down water on the surface of the land that is fast from rain water.

Regional Coverage of Malesia

Malesia was first identified as a floristic region which includes the Malay Peninsula, the Malay Archipelago, Papua, and the Bismarck Islands, based on shared tropical flora that mostly originates from Asia but also with various elements of Antarctic flora (Wikramanayake, et al. 2002). The separation of Malesia has provided a different understanding from the World Geographical Scheme for Recording Plant Distributions (WGSRPD) in 2001 as seen in below.

Figure 1. Coverage Area of Malesia.

Source: World Geographical Scheme for Recording Plant Distributions (2001).

Malogeographic biogeographic section extending through the Equator and the restrictions of the Indomalayan and Australasian ecozones, and also the phylogistic geographical region with zone dispersal as follows:

• Sunda Strait

Sunda Strait covers the western part of Malesia, which consists of the Malay Peninsula and the island of Sumatra, the island of Java, the island of Bali, and the island of Borneo. These islands are on the relatively shallow Asian continental shelf, and were connected with Asia during the ice age, when sea levels were lower. The eastern edge of Sundaland is the Wallace line.

• Philippines

The Philippines has never been attached with continental Asia, but has general flora that mostly originates from Asia as well as a distinctive mammalian wildlife.

• Wallacea

The islands sandwiched between the Sunda Strait and Papua New Guinea called Wallacea have never been joined with nearby continents. Wallacea has flora and fauna which includes elements of Indomalaya and Australasia. Papua New Guinea and the Bismarck Islands (Sahulland) are more widely located into the Papuasia region than in Malesia. The eastern end of Malesia includes Papua New Guinea and the Aru Islands in eastern Indonesia and is connected to Australia by shallow continental shelf.

Moss diversity in the Malesia area

The dispersion of Malesia mosses is closely related to tropical forest habitat (Ellis 1992). The study of the diversity and distribution of Malesia mosses is an important concern because of the increasing rate of destruction of tropical forests throughout the Malesia region (Tan.B.C, 1996). The pattern of distribution of mosses in the region is in accordance with the diverse composition of the Malesia Moss Taxa. Distribution of Malesia mosses is closely related to tropical forest habitat, the study of the diversity and distribution of Malesia mosses is an important concern because of the increasing rate of destruction of tropical forests throughout the Malesia region. The dry and semi-deciduous forest of Palawan has a relatively depauperate moss flora compared with the flora of moist forest on other islands of similar area, showing little influence from Borneo. Geographical distribution of true mosses can be grouped into eleven types, namely endemic to Sulawesi, the types of lichens which cross East Malesia, West Malesia, Malesia, East Asia, Southeast Asia, including Malesia extending to the Pacific and or Australia, Paleotropic, Pantropic, spread throughout the southern hemisphere, scattered throughout the northern hemisphere, and spread very widely in almost all parts of the world (cosmopolitan). Most liverworts have a wide geographical distribution covering the tropical regions of Asia, the Pacific and Australia. Some types of liverworts do not spread west across the Wallace line. Table 1 shows a list of mosses found in that region.

Table. 1. List of Malesia mosses that have been found.

No	Moss Name	Dispersion
1.	*Chameleion peguense, Horikawaea redfearnii*	Indochina-Philippina
2.	*Trachyladiella aurea*	Eastern Himalayas, the Mountains of China, Taiwan, Sulawesi Mountains, dan Seram West Java
3.	*Dawsonia superba, Bescherellia elegantissima*	Australiasian/ Oceania or Southern Malesia / Philippine Border
4.	*Thuidium sparsum*	Eastern Australia, Tasmania and Netherlands
5.	*Mittenia plumula*	Papua New Guinea, Australia, Tasmania and Netherlands, Northern Borneo.
6.	*Orthorrbynchium elegans*	Sunda Strait and Mindanao
7.	*Aongstroemia orientalis*	Asian Mountains, Himalaya, India, Indochina, Japan, Philippine, Borneo (Mount Kinabalu), Java (Mount Sumbing), Lombok (Mount Rinjani)
8.	*Tortula caroliniana*	North America and Papua New Guinea
9.	*Diphyscium chiapense*	Japan, Mindanao (Mount Kitanglad), Mexico
10.	*Entodon concinnus*	Papua New Guinea, Ecuador
11.	*Rhytidium rugosum*	Irian Jaya, Papua New Guinea
12.	*Haganiella Micans*	China, Taiwan, Philippine, Borneo, Java, Hawaii, Canada
13.	*Brachymenium capitulatum*	Africa, Madagascar, Taiwan and Papua New Guinea
14.	*Caduciella mariei*	Tanzania, Comoro Island, India, China, Indochina, Malesia, Oceania and Australia.
15.	*Takakia Lepidozioides*	Columbia, Japan, Nepal, China and Borneo
16.	*Syrrhopodon strictus*	Srilanka and Irian Jaya
17.	*Fissidens subbryoides*	India, Andaman Island and Seram (Indonesia)

Source: Adapted from Tan (1990).

The bioregion of Australian Wet Tropics is known to be bryophyte diversity hotspot. 397 moss taxa were identified after wide-ranging field work and studies of taxonomic which have further many taxa particularly to the Wet Tropics bryophyte flora. A number of records including Holomitrium cylindraceum and Taxithelium lindbergii are reported as new to Australia (Cairns, 2019). The moss flora of Zambales Mountain Range of Luzon Island, Philippines has also been discovered to consist of 268 species in 126 genera. The Zambales collections yield Ectropothecium sp., a probable new species and six new records for the Philippine moss flora (Linis, 2019). A latest, lesser known collection of mosse from Mt. Halcon, Mindoro Island, the Philippines, has generated two registers for the country namely (Rhacocarpus alpinus (Wright) Par. and Dicranoloma daymannianum Bartr.) and other eight latest records also discovered for the island (Tan, B. C., & Mandia, E. H, 2001). 101 genera and 174 species of mosses are discovered in Mt. Wilhelm in Papua New Guinea which is based on gatherings from 2000-4300 m elevations. *Brotherella longipes* is testified to become new finding to New Guinea as well as East Malesia.

Mosses have important roles for ecosystem which is also needed for conserving water balance to become habitat for other organisms in the domain Kabura-burana River Basin in Southeast Sulawesi. A qualitative study from Endang (2020) using exploratory methods has obtained 15 species of mosses consisting of 4 species of liverworts and 11 species of leaf lichens. Mosses of Gunung Halimun National Park,West Java is where 150 species of mosses

in 74 genera and 25 families are documented for the first time. Distichophyllum collenchymatosum, D. malayense and Fissidens kinabaluensis are considered to be three new mosses to the Indonesia flora as well as other four new records of mosses for Java which include dicranodontium asperulum, Daltonia armata, Glossadelphus bilobatus and Syrrhopodon semiliber. These seven discoveries are classified to be on the category uncommon mosses of Malesian region (Tan, B. C., 2006). 81 species and 4 vareties were also accounted from a survey of the Endau Rompin National Park (ERNP) in Johore State. 111 species and 5 varieties are added to the list in which 30 species are regarded as recent records for Johore State. Two spesies are considered as latest records to the Peninsular Malaysia namely, Rhaphidostichum bunodicarpum and Trichosteleum stigmosum as well as Thuidium assimile is for West Malesia (Ho, B. C., & Tan, B. C, 2002).

4. Conclusions

The development of knowledge about the history of plate tectonics in the Malesia region is urgently needed to learn more about the distribution of various plant species including mosses, and to deepen the ecological, reproductive, and biological distribution. Information from these sources can support and substantiate hypotheses, leading to a deeper understanding of the evolution of the environment from the geological and climatic environments that have come up.

The objective of the review which accumulates some prominent sources have achieved especially in gathering sources from BC. Tan from the period of 1993 to 2006. It is recommended that the future researchers can explore the the latest discoveries sightings which can also be deemed as new records and species in regard to this particular flora. The will provide accurate information on the diversity of species of bryophytes in Malesia.

References

Alamgir, A. N. M. (2017). Pharmacognostical Botany: Classification of medicinal and aromatic plants (MAPs), botanical taxonomy, morphology, and anatomy of drug plants. In *Therapeutic Use of Medicinal Plants and Their Extracts: Volume 1* (pp. 177-293). Springer, Cham.

Ariyanti, N. S., Gradstein, S. R., Sporn, S. G., Angelika, R., & Tan, B. C. (2009). Catalogue of the bryophytes of Sulawesi. Supplement 1: new species records. *Blumea-Biodiversity, Evolution and Biogeography of Plants*, *54*(1-2), 287-289.

Brummitt, R. K., Pando, F., Hollis, S., & Brummitt, N. A. (2001). *World geographical scheme for recording plant distributions*. Pittsburg: International working group on taxonomic databases for plant sciences (TDWG).

Cairns, A., Meagher, D., & Ramsay, H. (2019). A revised checklist of the moss flora of the Australian Wet Tropics. *Telopea*, *22*, 1-30.

Ellis, L. T. (1992). Towards a moss flora of southern India. *Bryobrothera*, *1*, 133-136.

Endang, T. (2020). Inventarisasi Jenis-Jenis Lumut (Bryophyta) di Daerah Aliran Sungai Kabura-Burana Kecamatan Batauga Kabupaten Buton Selatan. *Jurnal Biologi Tropis*, *20*(2), 161-172.

Fink, A. (2019). *Conducting research literature reviews: From the internet to paper*. Sage publications.

Gradstein, S. R., Tan, B. C., Zhu, R. L., HO, B. C., DRÜBERT, C., & PITOPANG, R. (2005). A catalogue of the bryophytes of Sulawesi, Indonesia. *The Journal of the Hattori Botanical Laboratory*, *98*, 213-57.

Ho, B. C., & Tan, B. C. (2002). Additions To The Moss Flora of Endau Rompin National Park, Johore State, Peninsular Malaysia. *Tropical Bryology*, 67-76.

Johns, R J (1995). Malesia - sebuah pengantar. *Curtis Majalah Botani* 12: 52-62.

Linis, V. C. (2019). Notes on the diversity and floristic affinity of mosses (Musci, Bryophyta) from Zambales Mountain Range, Luzon island, Philippines. Phytotaxa, 388(1), 69-97.

Nunik, S. A., & Gradstein, S. R. (2007). Wallace's line and the distribution of the liverworts of Sulawesi. *Cryptogamie, Bryologie*, *28*(1), 3-14.

Shaw, A. J., & Goffinet, B. (Eds.). (2000). *Bryophyte biology*. Cambridge University Press.

Tan, B. C. (1990). Six new taxa of Malesian mosses. *Bryologist*, 429-437.

Tan, B. C. (1996). Biogeography of Palawan mosses. *Australian Systematic Botany*, *9*(2), 193-203

Tan, B. C. (1998). Noteworthy disjunctive patterns of Malesian mosses. *Biogeography and Geological Evolution of SE Asia. Backhuys Publisher, Leiden*, 235-241.

Tan, B. C., & Mandia, E. H. (2001). New and noteworthy records of mosses from Mindoro, Philippines, and their biogeographical implication. *Gardens' Bulletin Singapore*, *53*, 315-322.

Tan, B. C. (2000). Additions to the moss floras of Mt. Wilhelm Nature Reserve and Mt. Gahavisuka Provincial Park, Papua New Guinea. *The Journal of the Hattori Botanical Laboratory*, *89*, 173-196.

Tan, B. C., Ho, B. C., Linis, V., Iskandar, E. A., Nurhasanah, I., Mulyati, S., & Haerida, I. (2006). Mosses of Gunung Halimun National Park, West Java, Indonesia. *Reinwardtia*, *12*(3), 205-214.

Wikramanayake, E. D., Dinerstein, E., & Loucks, C. J. (2002). *Terrestrial ecoregions of the Indo-Pacific: a conservation assessment* (Vol. 3). Island Press.

Percentage contribution of each author in the manuscript

Risjunardi Damanik - 100%