Ecology and Disturbances in Bryophytes

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Abstract. Bryophytes is a non vascular plant that has many benefits. However, the population and diversity of its kind experienced a significant decline. This decrease is caused by several factors such as deforestation, forest fragmentation, air and soil pollution and climate change. All these factors are caused by natural activities and mainly caused by human activities that make use of the environment without preserving nature.

1. Introduction
Indonesia is an archipelago on the equator. The land is covered by 120.6 million hectares of forest, or about 63% of the land area. Indonesia's location in the equator makes Indonesia has a tropical climate and becomes one of the countries with high biodiversity. In addition to its forest area, Indonesia is also covered by 14.9 million hectares of peatland[1].

Sumatra is one of the largest islands in Indonesia, 1,700 km long and 350 km wide. This area is dominated by Bukit Barisan mountains that stretch from the north end to the southern tip of Sumatra. The highest peak is Mount Kerinci with an altitude of 3,804 meters above sea level. Bukit Barisan in the West is more humid when compared to the eastern part. Sumatra's diverse ecosystem makes Sumatra has a high diversity and endemcity. Some areas were later used as centers in situ conservation areas in the form of National Parks [2]. However, currently the number of forest cover in Sumatra is decreasing, due to the transfer of forest functions for economic activities and human settlements [2].

Land use for economic activities poses a very big problem for forest areas, especially sumatran forests. The transition of forest functions into dwellings, highways, industrial estates and plantation land caused a drastic decline in forest area. Some people also do forest burning deliberately to open land, this forest fire became a very serious problem and became a concern of the international world. According to[2], Sumatra lost 3666.2 thousand hectares during the period 2009-2013, and became the area with the highest fire point. The most fires occurred in South Sumatra, then followed by North Sumatra and Riau. [3] also mentioned that forest fires in Indonesia greatly affect the flora and fauna that make the forest as their habitat. The Red Data List shows 772 species of endangered flora and fauna. One of the endangered flora is Bryophytes.

Deforestation activities greatly affect the survival of mosses especially epiphytic Bryophytes. Epiphytic Bryophytes depend on forest ecosystems, especially rainfall, temperature and humidity are...
greatly disrupted by land transfer, logging and forest fires. The morphology of Bryophytes and the way they breed are also strongly influenced by their habitat [3], [4]. This is also because, Bryophytes in the Asian region are more in the form of epiphytic Bryophytes attached to the bark and leaves of plants in the forest [5], [6].

2. Methods
This research uses literature study methods derived from journal articles that discuss about mosses and the factors that can influence their extinction. The articles taken mostly come from international publications, this is because moss research in Indonesia is still very rare.

3. Results and Discussion
There are many factors that affect the number of types of Bryophytes including deforestation, forest fragmentation, air pollution and climate change. Almost all of these factors are caused by humans. Some types of Bryophytes experienced a drastic decrease in number, resulting in almost extinction. [7] found that the Spruteanthus theobromae (Lejeuneaceae) which is an endemic liverworth in cocoa plantations in the Dominican Republic is almost extinct. The reduction in moss population is due to the lack of care on the plantation.

The following will be presented several factors that affect the number of species and populations of Bryophytes in nature.

3.1 Deforestation
Deforestation is one of the most influential factors in biodiversity. In the tropics, many of its regions are converted into agricultural land. [8] conducted research in Sulawesi. He found that there is a difference in the number of types of moss in cocoa plantations and surrounding forests. This cocoa plantation comes from a forest that was cut down and converted into a garden. Drought-tolerant types of moss will be found in both locations. While sensitive types of moss are found only in forest areas [9] compared epiphytic Bryophytes in several habitats in Neotropic countries and Indonesia (Sulawesi), including rainforest areas, secondary forests, grasslands and cocoa plantations. They found there was a specific diversity of species between natural forest areas and disturbed forests. [10] added that drought-intolerant species have a profound effect on deforestation.

3.2 Fragmentation
Deforestation causes forest fragmentation in many forest areas in the tropics [11], [12] found that there is an influence of forest fragmentation on ephipilous Bryophytes located in the Amazon. He stated there would be a reduction in the number of types in fragmented areas. In the wider fragment area will be found more varied types and high density of types. As Söderström research [13] found, habitat fragmentation is one of the problems that greatly affects species diversity in forests. Fragments with a large area will only reduce the number of species, but in the wider fragments will lead to the extinction of the species.

3.3 Air and Soil Pollution
In temperate climates, mosses are able to accumulate heavy metals [14], although in Bryophytes in the tropics research on this is still lacking [11], [15], conducted research in Cezarina, Brazil. They found the presence of sulfur accumulation in Bryophytes tissues growing in areas with high sulfur content. These types fall into the group of Fabroniaceae, Hypnaceae and Helicophyllaceae. Research on the accumulation of other heavy metals was conducted by [16] in the Sri Lanka mountain rainforest. The observed plants came from various groups, such as Usnea barbata (Lichen), Pogonatumurnigerum (Moss), Lycopodium ulago (fern), Polypodium laneolatum (Fern), Bulbophyllumelliae (Orchid), and Actinodaphneambigua (Spermatophyta). Of all the plants observed, elements as, Cd, Co and Pb are most commonly found in the moss tissue Pogonatumurnigerum (Figure 1).
3.4 Climate Change

Climate change in the tropics has a profound effect on moss populations [11]. This happens because mosses are very sensitive to temperature. [17] research mentioned that a 1.5°C rise in temperatures in mountain forests in Bolivia could affect epiphytic moss communities within 2 years. So, mosses can help to see how quickly climate change is occurrence.

4. Conclusions

Bryophytes is a non vascular plant that has many benefits. However, the population and diversity of its kind experienced a significant decline. This decrease is caused by several factors such as deforestation, forest fragmentation, air and soil pollution and climate change. All these factors are caused by natural activities and mainly caused by human activities that make use of the environment without preserving nature.

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Figure 1. Pogonatumumigerum [11].
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