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The liverworts family Plagiochilaceae of Taman Eden 100 Natural Park, North Sumatra Indonesia

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Abstract. Information on the liverworts family Plagiochilaceae in Taman Eden 100 Natural Tourist Park North Sumatra has never been reported. This study aims to invent the spesies of Plagiochilaceae at Taman Eden 100 Natural Park, North Sumatra to complete the liverworts data of Sumatra. Samples were collected by exploring and surveying accessible path within the research site. The observation was done in the laboratory based on morphological characters under the binocular microscope. Identification of the species used some existing literature that contains key identification, description or illustration of Plagiochilaceae. Sixteen species of Plagiochilaceae were found in this area, including three genera: *Pedinophyllum* (1 species), *Plagiochilon* (1 species), and *Plagiochila* (14 species). The most common species found in the study was *Plagiochila arbuscula*, while the uncommon species found were *Plagiochila frondescens*, *P. sumatrana*, and *Pedinophyllum sp.*

1. Introduction

Plagiochilaceae is a large family of the liverworts, consists of seven genera, and about 450 currently accepted species around the world [1]. The family is recognized by some characters such: leaves succubous, margin with sharply toothed, bases of dorsal margin decurrent; often with a rhizome-like creeping base; underleaves usually lack (or very small); androecia in a long, terminal or intercalary spikes.

Plagiochilaceae, like the other Bryophytes play an important role in forest ecosystem, as water storage in tropical ecosystems, help to keep humidity, pollution indicator, and offer shelter to other organisms. Some species of the family are useful as anti-fungal, and potential for medicine [2, 3].

Information of Plagiochilaceae in Indonesia is still limited. Previous study on Plagiochilaceae which has been reported in Java [4], and Sulawesi [5]. Study on Plagiochilaceae in Sumatra is relatively scanty. A monograph of genus *Plagiochila* of Southeast Asia had published by [6], who listed 31 species from Sumatra, especially West Sumatra. However, information of Plagiochilaceae in North Sumatra is still rarely reported until now. Previous studies on Plagiochilaceae in North Sumatra are: 12 species at the tourist park forest Deleng Lancuk [7], and 18 species at Mount Lubuk Raya [8]. More intensive studies on Plagiochilaceae in North Sumatra will find a greater number of species. Taman Eden 100 Natural Park is one of the suitable habitat for Plagiochilaceae, based on humidity and altitude above sea level from 1,100 to 1,750. This area is one of the locations that considered to play an important role in environmental sustainability. The collection and information about Plagiochilaceae of Taman Eden 100 Natural Park have never been reported. So it is necessary to study the liverworts family Plagiochilaceae



of Taman Eden 100 Natural Park to invent the species richness, in order to complete the liverworts data of Sumatra as well as Indonesia.

2. Materials and methods

2.1. Study site

Taman Eden 100 Natural Park is located administratively in Sionggang Utara village, Lumban Julu district, Toba Samosir regency, Sumatera Utara Province, with an area of ± 1000 ha. The study site is geographically located in between $02^{\circ} 39'00''$ - $02^{\circ} 42'00''$ E and $099^{\circ} 62'00''$ - $099^{\circ} 64'00''$ N. The relative humidity is 96.64% and the light intensity is 1627.98 lux meters. The daytime air temperature is 20.01°C and the topography is generally hilly with a height of 1,100 to 1,750 m.a.s.l. The common vegetation found are Theaceae, Pinaceae, Araliaceae, Annonaceae, Fagaceae, Meliaceae, Myrtaceae and Orchidaceae.

2.2. Field methodology

The research was conducted by exploring and surveying the accessible paths within the research site. All suspected species of Plagiochilaceae found during exploration were noted for their key characters including substrates and color. The specimens were photographed, and sampled by using a knife or pickup tool, while date and collector's names were also recorded. Specimens were collected completely for their vegetative and generative organ. The specimens were inserted into the dry envelope assigned with a collection number. Physical conditions were measured during field exploration: coordinate points by using Global Positioning System (GPS), altitudes, temperature, relative humidity, light intensity and soil pH by using standard measurement tools.

2.3. Morphological observation and identification

Morphological observation is carried out by taking sufficient sample pieces of specimens. Furthermore, the pieces were soaked in water, and the base was clamped with a pointed pinset, then one leaf blade was removed. The leaf was later placed on top of object glass covered and observed under a light microscope. Key characteristics observed included: height and width of plants, lobes (shape, base, margin, apex, *trigone* cell), underleaves, saccs, and perianth. The specimens were identified at the Laboratory of Plant Taxonomy, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, using Plagiochilaceae publications primarily in the Asian region. All specimens found are deposited in MEDA Herbarium Department of Biology, Universitas Sumatera Utara.

3. Results and discussions

The study found 16 species of liverworts family Plagiochilaceae, belonging to three genera: *Pedinophyllum* (1 species), *Plagiochilion* (1 species), and *Plagiochila* (14 species).

The genus *Plagiochila* was more commonly found than other genera, indicating that *Plagiochila* is the largest genus of the Plagiochilaceae family. The finding was in accordance with [6], stating that *Plagiochila* is the largest genus of Plagiochilaceae.

Total species found in this study were considered almost identical compared to the number recorded by Siregar [8, 9]. However, the total number of species found in this study was more than Firina [7] who reported 12 species of Plagiochilaceae from tourist park forest Deleng Lancuk North Sumatra. The differences in the number of species might be caused by the variation of altitudes in each location.

Increasing altitudes may also affect the species richness of bryophytes. Other factors that may also cause the results of low species found in a certain area were intensities of collecting and environmental factors [5]. Furthermore, Gradstein et al. [10], stated that there were also several ecological factors affecting the species richness such as the duration of time during collecting and the number of experts involved. The growth of bryophytes was affected by environmental factors such as temperature, humidity and light intensity [11].

In addition to physico-chemical factors, the growth of bryophytes is also supported by the substrate. Most species of the liverworts family Plagiochilaceae found in this study were living on tree trunk. The tree base is a suitable substrate for bryophytes because of its micro climate, a high humidity condition

in transitional zone between the forest floor and the tree trunk. Bryophytes that grew on trees would be affected by the surface structure of the wood bark, or site with sufficient light and humidity [5, 8].

List of Plagiochilaceae found on Mount Lubuk Raya, arranged alphabetically.

a. Plagiochila arbuscula (Brid ex Lehm et Lindenbg) Lindenbg.

4: 63. 1832. Spec. Hepat. 1–5: 23. 1839; Inoue, *Plagiochila* Southeast Asia: 64–66. 1984; Piippo, Ann. Bot. Fennici 26: 205 - 207. 1989; So, Syst. Bot. Monogr. 60: 103– 06. 2001; *Jungermannia arbuscula* Brid. ex Lehm, Pugillus Coll. Specimens: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1300-1445 m, E. Siregar 3592, 3532, 3598, 3597, 3610, 3512, 3463, 3462, 3452, 3752, 3756, 3282, 3108, 3577, 3657, 3484, 3433, 3432, 3402, 3381, 3382, 3392, 3401, 3362, 3421, 3154, 3533, 3542, 3639.

b. Plagiochila bantamensis (Reinw et al.,) Dum.

D'Orbigny, Voy. Amer. Merid. 7. Bot. (2): 82. 1839; Inoue, *Plagiochila* Southeast Asia: 39–43.1984; So, Syst. Bot. Monogr. 60: 21–25. 2001; *Jungermannia bantamensis* Reinw., Blume and Nees. Nova. Acta Caes. Leop. 12: 235. 1825. Specimens: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1300-1404 m, E. Siregar 3663, 3664, 3670, 3734, 3760, 3321, 3621.

c. Plagiochila denticulata Mitten, J. Proc. Linn. Bot.

Mitten, J. Bot., Soc. 5:95. 1860. *Plagiochila horridula* Stephani, Sp. Hepat, 6. 1918. Type India. WestnBengal: prope Kurseong, 6000 ft, Decoly & Schaul s.n. (holotype:G-009746: isotype: BM). North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1315-1367 m, E. Siregar 3281, 3193, 3688, 3628, 3442, 3646, 3453, 3412, 3351.

d. Plagiochila frondescens (Nees) Lindenbg

In Lindenbg., Spec. Hepat: 52(1840); *Jungermannia frondescens* NEES, Linnae 6: 610 (1831). Only one specimen was found. Specimen: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. ca. 1445 m, E. Siregar 3591.

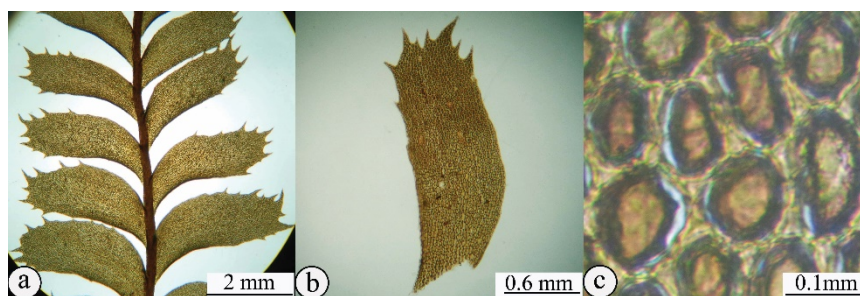


Figure 1. *Plagiochila frondescens* a. Habit b. Leaf c. Leaf cell.

e. Plagiochila javanica (Swartz) Dum.

Rec. d'Obs. Tounay: 15. 1835; Inoue, *Plagiochila* Southeast Asia: 93–95. 1984; *Jungermannia javanica* Swartz, Methodus Muscorum Illustrata: 35, tab. II. Fig. 2. 1781. Specimens: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1300-1367 m, E. Siregar 3224, 3722, 3721, 3232, 3658, 3716, 3371.

f. Plagiochila junghuhniana S. Lac.

Ned. Kruidk. Arch. 3: 416. 1855; Inoue, *Plagiochila* Southeast Asia: 84–85. 1984; So, Syst. Bot. Monogr. 60: 151–153. 2001. Specimens: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. ca 1445 m, E. Siregar 3645, 3680.

g. Plagiochila laxissima Schiffn

Denkschr. Math.-Nath. CI. K. Akad. Wiss. Wien 70: 163 (1900). Specimens: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1315-1367 m, E. Siregar 3593, 3290.

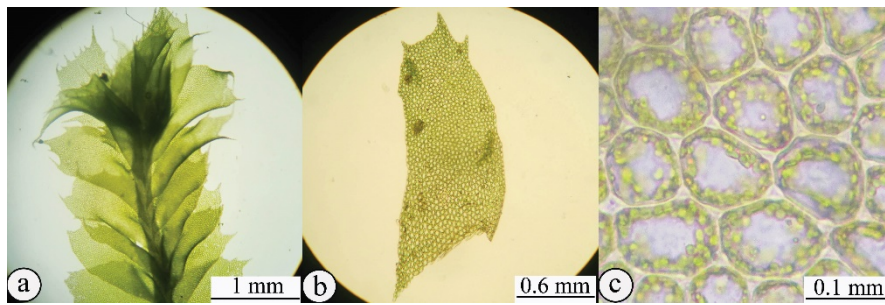


Figure 2. *Plagiochila junghuhniana* a. Habit b. Leaf c. Leaf cell.

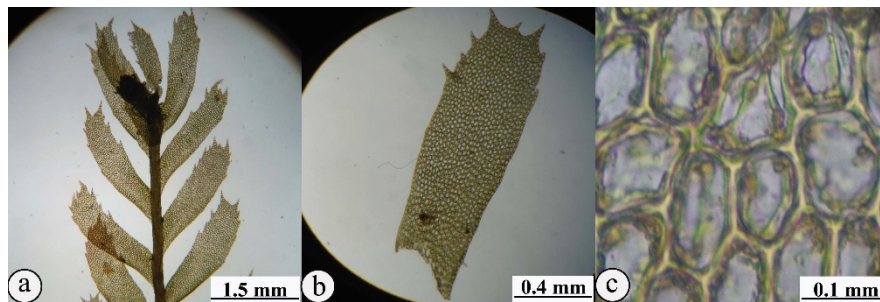


Figure 3. *Plagiochila laxissima* a. Habit b. Leaf c. Leaf cell.

h. Plagiochila manillana Mont. Et Gott.

Ann. Sci. Nat. Bot. Ser. 4,6: 189 (1856). Specimens: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1315-1367 m, E. Siregar 3341, 3739.

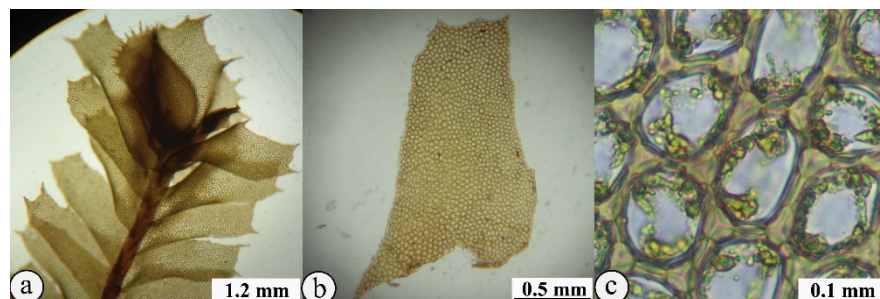


Figure 4. *Plagiochila manillana* a. Habit b. Leaf c. Leaf cell.

i. Plagiochila obtusa Lindenbg.

Spec. Hepat. 1–5: 42. 1840; Inoue, *Plagiochila* Southeast Asia:77–78. 1984. Specimens: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1367-1404 m, E. Siregar 3342, 3675.

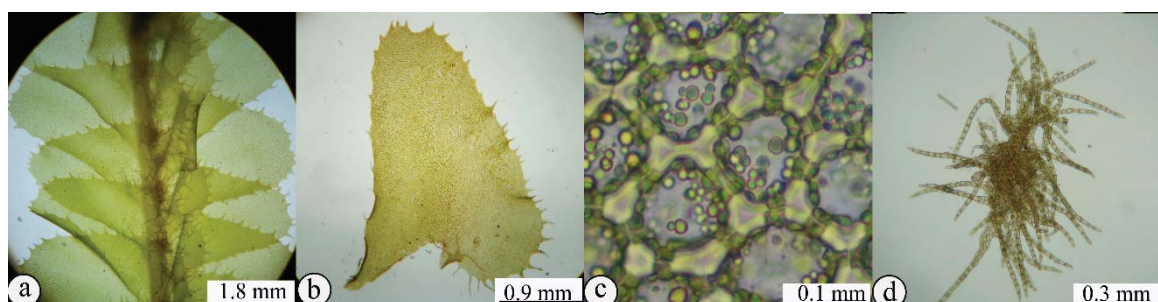


Figure 5. *Plagiochila obtusa* a. Habit b. Leaf c. Leaf cell d. *Paraphyllia*.

j. Plagiochila salacensis Gott.

Natuurk. Tijdschr. Ned. Indie 4: 576. 1853; Inoue, *Plagiochila* Southeast Asia: 71–73. 1984; So, Syst. Bot. Monogr. 60: 164. 2001. Specimens: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1300–1404 m, E. Siregar, 3005, 3184, 3194, 3203, 3204, 3213, 3214, 3331, 3367, 3537, 3572, 3574, 3587, 3627.

k. Plagiochila sandei Dozy.

Ned. Kruidk. Archief. Leiden 4: 92. 1856; Inoue, *Plagiochila* Southeast Asia: 37–38. 1984. Specimens: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1300–1445 m, E. Siregar, 3555, 3606, 3155, 3473, 3657, 3164, 3411, 3372, 3761, 3740, 3728, 3652, 3633, 3609, 3685, 3311, 3615, 3243, 3582, 3227, 3575, 3554.

l. Plagiochila sciophila Nees.

Spec. Hepat. 1–5: 100. 1840; Inoue, *Plagiochila* Southeast Asia: 125–130. 1984; So, Syst. Bot. Monogr. 60: 112–116. 2001. Specimens: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1300–1404 m, E. Siregar, 3686, 3751, 3615, 3263, 3646, 3183.

m. Plagiochila singularis Schiffn

Denkschr. Math. Nat. Cl. K. Akad. Wiss. Wien 70: 187. 1900; Inoue, *Plagiochila* Southeast Asia: 118–120. 1984. Specimens: North Sumatra: Mount Lubuk Raya, on the tree trunk and rotten log, alt. 1300–1445 m, E. Siregar, 3318, 3757.

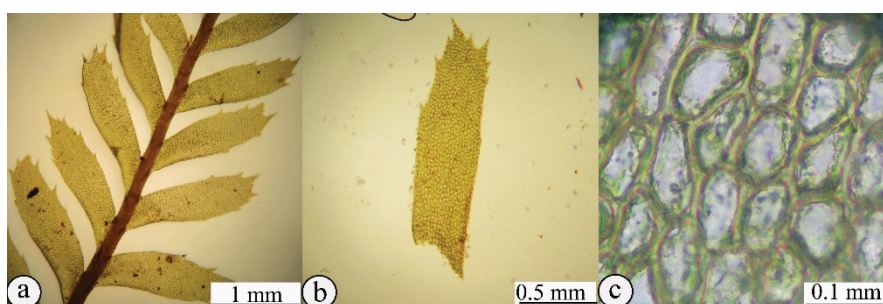


Figure 6. *Plagiochila singularis* a. Habit b. Leaf c. Leaf cell.

n. Plagiochila sumatrana Schiffn.

Denkschr. Math. Nat. Cl. K. Akad. Wiss. Wien 70: 183. 1900; Inoue, *Plagiochila* Southeast Asia: 111–112. 1984; Piippo, Ann. Bot. Fennici 26: 227. 1989. We found only one specimen. Specimen: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1404 m, E. Siregar, 3676.

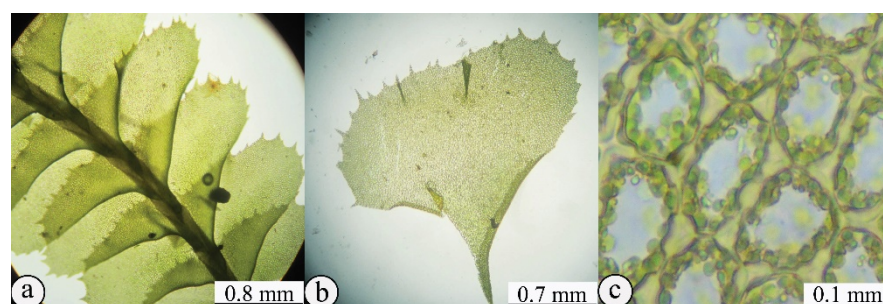


Figure 7. *Plagiochila sumatrana* a. Habit b. Leaf c. Leaf cell.

o. Plagiochilion oppositum (Reinw., Blume & Nees) S.Hatt.

Herzog 1939, Chopra 1943, Inoue 1964, Onraedt 1981, Grolle and Pippo 1984, Tan and Engel 1986, Menzel 1988, McCarthy 2006, Yamida and Iwatsuki 2006, Zhu 2006, Lai et al. 2008, Soderstrom et al.

2010, 2011a, Chuah Petiot 2011, Thouvenot et al. 2011, Wang et al. 2011. Specimens: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1367-1445 m, E. Siregar, 3614, 3767, 3581, 3615, 3573.

p. Pedinophyllum sp.

Specimen: North Sumatra: Mount Lubuk Raya, on the tree trunk, alt. 1445 m, E. Siregar, 3770.

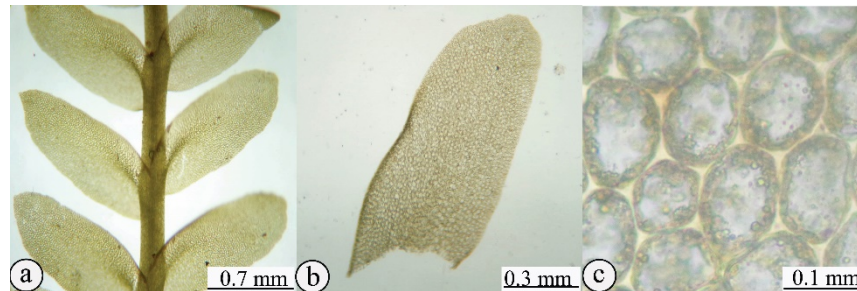


Figure 8. *Pedinophyllum* sp. a. Habit b. Leaf c. Leaf cell.

4. Conclusion and suggestion

There are 16 species of the liverworts family of Plagiochilaceae that consist of three genera: *Pedinophyllum* (1 species), *Plagiochilion* (1 species), and *Plagiochila* (14 species). It is expected to conduct the study on Plagiochilaceae in the different places to complete the species richness in Sumatra.

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