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Diversity of Bryopsidain the Cangar Forest, Batu, Indonesia

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Abstract : The objective of this research was to determine the diversity of mosses species from Cangar forest, Batu, Malang, East Java, Indonesia. The study was conducted using cruising method and observation was made on each leaf moss plants found on soil, trees, and stones habitat. The results showed that based on morphological and anatomicalcharacters analysis, 22muscispecieswere found from the exploration of Cangar forest, Batu. Seven species of mosses were found on the soil, 11 species were found on trees, and 4 species were found on stones habitat.
Keywords : moss, Cangar forest, morphology, anatomy.

Introduction

Antibiotic resistance is a global problem, not excluding Indonesia[1].This resistance is highly serious problem because it can lead to morbidity, mortality, and increase of society health care costs[2], in additional of causing side effects such as allergic reactions, immune system disorders, and hypersensitivity[3,4,5]. One of the efforts to overcome antibiotic resistance is to develop exploratory research of natural medicine originated from plants, because various plants is found to contain potential secondary metabolites that acts as natural antimicrobialagent[6,7,8,9,10].These natural materials is expected to be the next sources of new antimicrobial agents with new mechanisms[5,11].

Today various secondary metabolites are isolated from higher plants taxa, but secondary metabolites isolated from the lower plants taxa, especially musci endemic to Indonesia has not to be disclosed and conducted in Indonesia yet. In some countries, mosses is traditionally utilized by the community as medicine for various diseases[12]. Previous researches confirmed that methanol extracts of *Abietinella abietina*, *Neckeria crispa*, *Platyhipnidium riparoides*, *Cratoneuron filicinum*, and *Campylium protensum* were able to inhibit the growth of *Staphylococcus aureus*, *Bacillus cereus*, *Micrococcus flavus*, *Escherichia coli*, and *Salmonella typhimurium*[13].While ethanol extracts of *Dicranum scoparium*, *Atrichum undulatum*, *Rhytidia delphus squarrosus*, *Eurhynchium agustirete*, and *Rhodobryum roseum* were found to be able to inhibit the growth of bacteria*S.aureus*[14].

From other research, ethanol and water fractions of *Targionia hypophylla*, *Bryum argenteum*, *Bryum cellulare*, *Bryum coronatum*, *Bryum plumosum*, *Bryum pseudotriquertum*, and *Bryum capillarye* extracts showed strong antimicrobial activities against *Bacillus subtilis*, *E.coli*, *Pseudomonas solanacearum*, *Xanthomonas axonopodis*, *X. Visicatoria*, *Aspergillus ochreaceous*, *Aspergillus flavipes*, *Fusarium verticilloides*, and *Penicillium notatum*[15], whereas acetone, ethanol, and methanol extracts of mosses *Calym preserosum*, *Racopilium africanum*, and *Cyclodictyon sp*. were able to inhibit the growth of *Trichoderma spp*., *Sachharomyces cerevisiae*, *Microsporum gypseum*, *Candida albicans*, *Aspergillus niger*, *Klebsiella*

pneumoniae, *Escherichia coli*, *Streptococcus pyrogenes*, *Staphylococcus aureus*, and *Bacillus subtilis*[16]. Butanol fraction of *Bryum argenteum* and *Mnium marginatum* were also shown able to inhibit growth of bacteria *S.aureus*[17].

Studies of mosses diversity have been carried out frequently, but the study on algae diversity grew on trees, soil, and stones habitat based on morphological and anatomical character has few report. Based on the premise above, this study was aimed to identify various musci species grew on trees, soil, and stones habitat from the exploration results of Cangar forest, Batu, Malang, East Java, Indonesia.

Materials and Methods

The main materials used on this study were various species of music obtained from Cangar forest, Batu, Malang, East Java. Instruments used in this study including moss sampling equipment, such as pulley, achromatic magnifier, collection envelopes, and collection bags. Instruments used for description and determination were object glasses, cover glasses, and microscope.

A. Mosses Collection

Mosses collection was done by the following explanation: Moss samples were taken from soil, rocks, and trees habitat in the Cangar forest, Batu. Sampled mosses were observed with an achromatic magnifier to verify the validity of samples and avoid double sampling. Moss samples were taken at various habitat(substrate), which were soil, trees, and stones. Chosen samples was mosses without any visible deformities and on adult phase already (sporophyte had grown on thallus). Moss samples were taken by using sampling device andplaced into moss collection bag. Each sample dmoss was numbered and environmental data was noted.

B.Moss herbarium

Moss herbarium preparation was conducted initially by cleaning moss samples using water, to cleanse moss specimens from dirt such as soil, dust, insects or other debris. Moss samples were cleaned using tweezers, knives or scissors. Clean moss specimens was air-dried for several minutes and placed on absorbent paper (newspaper), then laid out neatly so it did not eliminate or alter the properties and characteristics of the specimens. Absorbent paper containing moss specimens were pressed and dried using a dryer or heated under the sun. Specimens were checked for its dryness every 2 days because it should not be too dry. The dried specimens were put in herbarium envelope and data added to it on herbarium number, species and family of the specimens, collector's name, date of collection and environment data collected from sampling day. Moss herbarium envelopes were organized and grouped according to its taxa group and arranged alphabetically.

Results and Discussion

From the exploration results and moss collection in the Cangar forest, Batu, Malang,24mosses species were found. Among the24species, 22 species were identified as Musci, and the other 2specieswere identified as leafy liverworts (Hepaticopsida). Seven of the Musci plants were grew on soil, 11 species on trees, and4 species were found on stones (Table 1). Morphology and anatomy of the mosses was presented in Figure 1 and Figure 2.

Tabel 1.Mosses identification on various habitats

No	Ordo	Family	Genus	Species	Habitat
1	Dicranales	Leucobryaceae	*Leucobryum*	*Leucobryum aduncum* Dozy & Molk.	Tree
2	Hypnales	Neckeraceae	*Homaliodendron*	*Homaliodendron flabellatum* (Smith) Fleisch	Tree
3	Dicranales	Dicranaceae	*Dicranoloma*	*Dicranoloma reflexum* (C. Mȍll.) Renauld	Tree
4	Hypnales	Thuidiaceae	*Thuidium*	*Thuidium tamariscellum* (C. Mȍll.) Bosch & Sandelac.	Tree
5	Leucodontales	Meteoriaceae	*Barbella*	*Barbella pendula* (Sull.)Fleiscl	Tree
6	Leucodontales	Meteoriaceae	*Meteorium*	*Meteorium subpolytrichum* (Besch.) Broth	Tree
7	Bryales	Bryaceae	*Brachymenium*	*Brachymenium nepalense* Hook.	Tree
8	Hypnales	Hypnaceae	*Isotheciopsis*	*Isotheciopsis comes* (Griff.) Nog	Tree
9	Bryales	Hypnodendraceae	*Hypnodendron*	*Hypnodendron diversifolium* Broth & Geh	Tree
10	Hypnales	Hypnaceae	*Isopterygium*	*Isopterygium cf. minutirameum*(C. Mȍll.) Jaeg.	Tree
11	Bryales	Rhizogoniaceae	*Hymenodon*	*Hymenodon cf. angustifolius* Sande Lac.	Tree
12	Pottiales	Pottiaceae	*Hyophylla*	*Hyophylla javania* (Ness & Blume) Brid	Stones
13	Hypnales	Hypnaceae	*Vesicularia*	*Vesicularia montagnei* (Schimp.)	Stones
14	Hookeriales	Pilotrichaceae	*Cyclodictyon*	*Cyclodictyon blumeanum* (C. Mȍll.)	Stones
15	Hypnales	Brachytheciaceae	*Oxyrrhynchium*	*Oxyrrhynchium vagans* (Jaeg.)	Stones
16	Dicranales	Dicranaceae	*Dicranella*	*Dicranella coarctata*(C. Mȍll.) Bosch & Sande Lac.	Soil
17	Pottiales	Pottiaceae	*Barbula*	*Barbula indica* (Hook.)Spreng	Soil
18	Hookeriales	Hookeriaceae	*Callicostella*	*Callicostellaprabaktiana*(C. Mȍll.) Bosch & Sande Lac.	Soil
19	Bryales	Mniaceae	*Plagiomnium*	*Plagiomnium rhynchophorum*(Harv.) T.J. Kop.	Soil
20	Hypnales	Hypnaceae	*Isotheciopsis*	*Isotheciopsis comes* (Griff.) Nog.	Soil
21	Hypnales	Hypnaceae	*Ectropothecium*	*Ectropothecium monumentorum* (Duby) Jaeg	Soil
22	Fissidentales	Fissidentaceae	*Fissidens*	*Fissidens gedehensis* Fleisch.	Soil

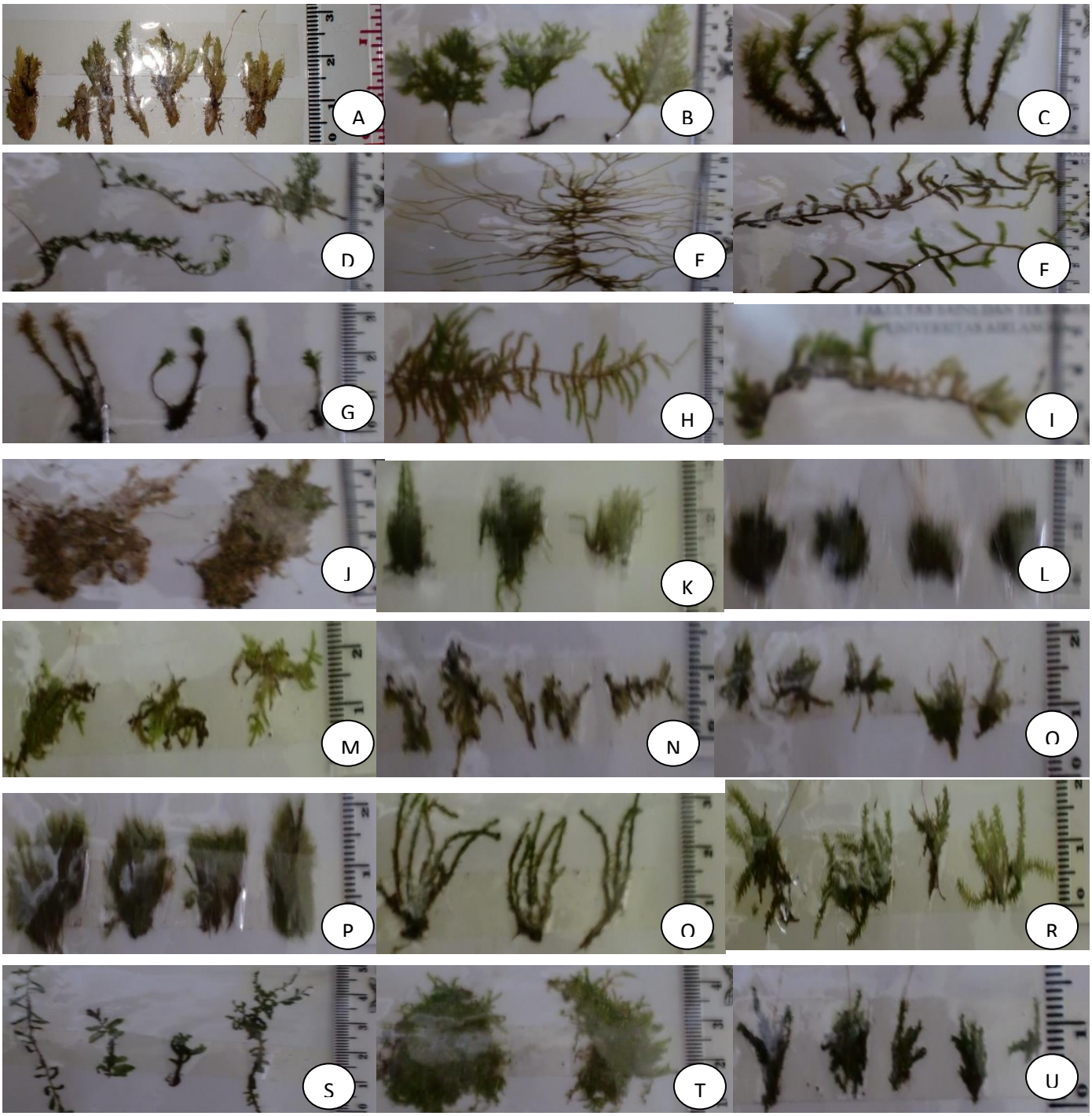
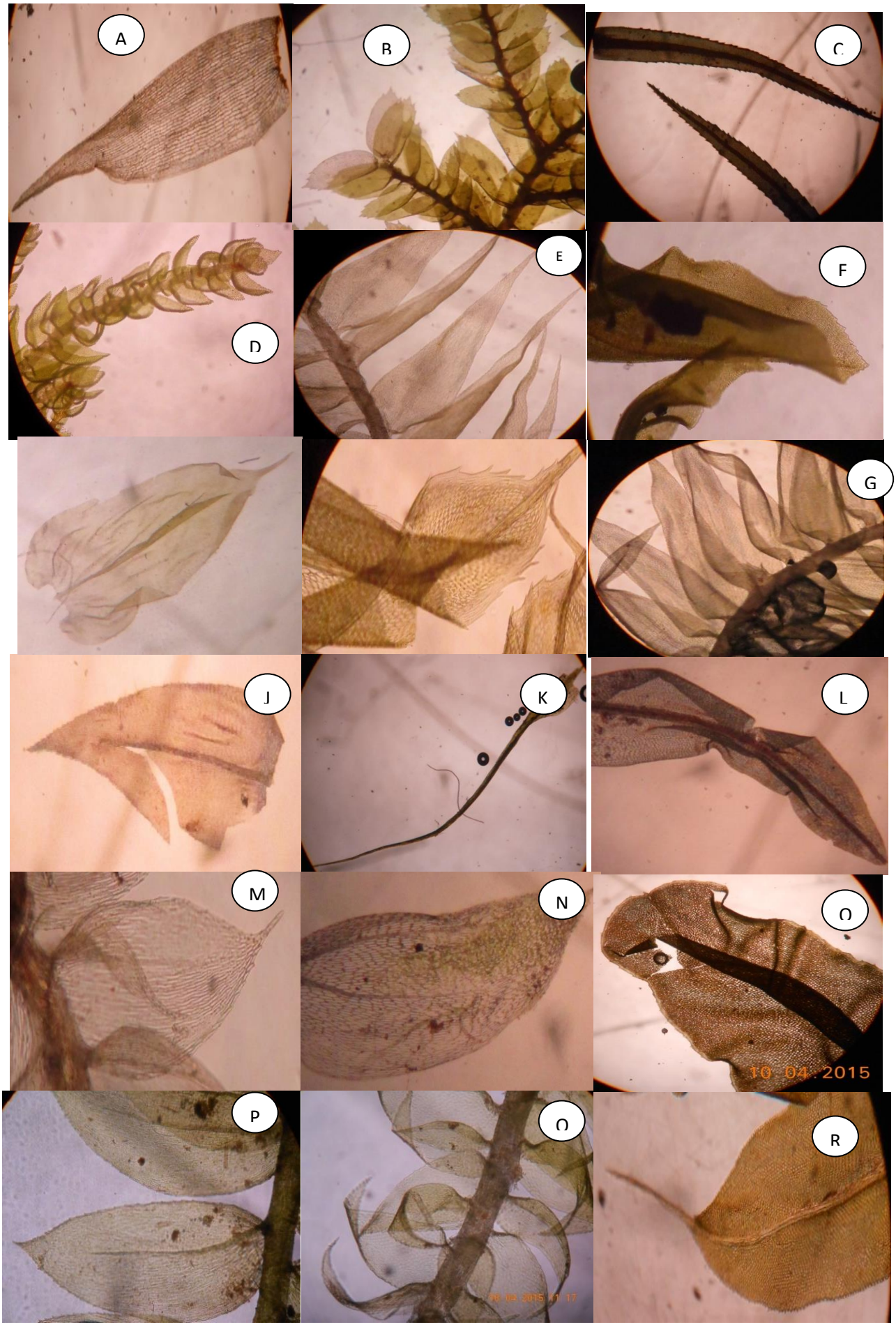


Figure 1. Morphology of the mosses

A.*Leucobryum aduncum* B. *Homaliodendron flabellatum*, C. *Dicranoloma reflexum*, D. *Thuidium tamariscellum*, E. *Barbella pendula*,F. *Meteorium subpolytrichum*,G. *Brachymenium nepalense*, H. *Isotheciopsis comes*, I. *Hypnodendron diversifolium*, J. *Isopterygium cf. minutirameum*, K. *Hymenodon cf. angustifolius*, L. *Hyophylla javania*, M. *Vesicularia montagnei*, N. *Cyclodictyon blumeanum*, O. *Oxyrrhynchium vagans*, P.*Dicranella coarctata*, Q.*Barbula indica*, R. *Callicostellaprabaktiana*, S. *Plagiomnium rhynchophorum*, T. *Ectropothecium monumentorum*, U. *Fissidens gedehensis.*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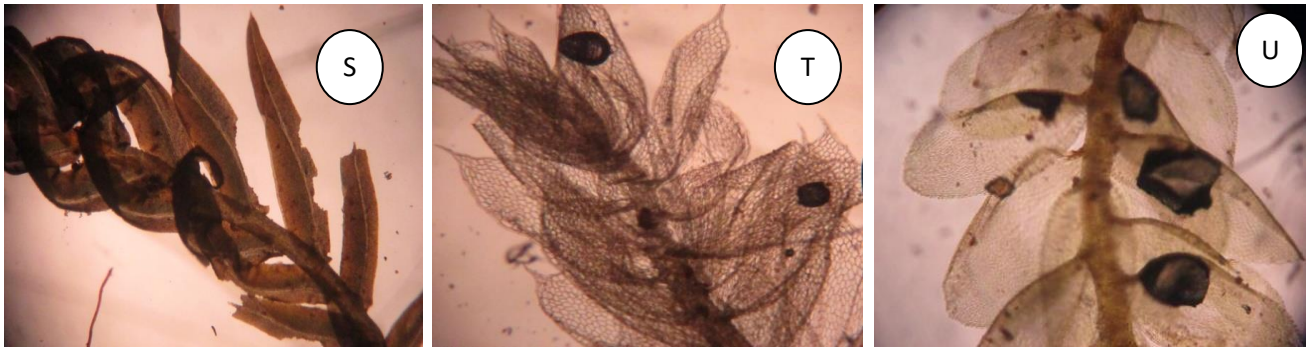

Figure 1. Anatomy of the mosses

A.*Leucobryum aduncum* B. *Homaliodendron flabellatum*, C. *Dicranoloma reflexum*, D. *Thuidium tamariscellum*, E. *Barbella pendula*,F. *Meteorium subpolytrichum*,G. *Brachymenium nepalense*, H. *Isotheciopsis comes*, I. *Hypnodendron diversifolium*, J. *Isopterygium cf. minutirameum*, K. *Hymenodon cf. angustifolius*, L. *Hyophylla javania*, M. *Vesicularia montagnei*, N. *Cyclodictyon blumeanum*, O. *Oxyrrhynchium vagans*, P.*Dicranella coarctata*, Q.*Barbula indica*, R. *Callicostellaprabaktiana*, S. *Plagiomnium rhynchophorum*, T. *Ectropothecium monumentorum*, U. *Fissidens gedehensis.*

Bryophyta is one of the biodiversity group found in Indonesia. Bryophyta consisted of three classes; Hepaticopsida/ Hepaticae, Anthocerotopsida, and Bryopsida/Musci. In the ecosystem, mosses served on resorbing water, retaining moisture, producing oxygen via photosynthesis, absorbing pollutants, improving forest ability to hold water(water holding capacity), functioning as habitat of other organisms such as invertebrates, medium for germination of higher plant seeds, and pollution bioindicator. Based on the results, most of the Musci was found on trees habitat (Table 1), compared to soil and stones. Bryophyta was commonly found in area with little light and moisture, mostly grew in tropical rain forest. Mosses usually grew on trees, stones, logs, and on the soil.

Distribution pattern and mosses diversity of Estonia was consisted of *Aulacomnium palustre, Brachythecium oedipodium, Dicranum polysetum, Dicranum scoparium, Hypnum cupressiforme, Hyclomium splendens, Lophocolea heterophylla, Pleurozium schreberi, Ptiliumcrista-castrensis, Rhizomnium punctatum, rhytidsdelphus triquestrus, Tetraphis pellucida*. The three species with highest relative frequency were *Hyclomium splendens, Pleurozium schreberi, Ptiliumcrista-castrensis*, respectively of 95.8%, 92%, and74.8% frequency[18].Musci diversity of Assam valley wet evergreen forest, Assam, India was consisted of 10orders, 27families,71generaand127species[19].

Diversity of moss plants in Mt.Kitanglad Natural Park was consisted of 428 species.Bryopsida was comprised of 70 genera and 29 families, Hepaticopsida of 16 genera and 11 families, and Anthocerotopsida of 2 genera and 1 family[20]. Musci collection of Adeyemi College of education Campus Ondo, Nigeria was consisted of six species; *Barbuleslam barenensis*, *Bryum coronatum*, *Hyophila involuta*, *Calym peresafzelii*, *Octoblepharum albidium*, and*Thuidium gratum*[21].Musci diversity in Central Sulawesi, Indonesia was consisted of 16 families and 78 species[22], while musci diversity in the Antarctic Peninsula was consisted of 15 families and 45 species[23].

Acrocarp mosses collected from Mount Melendiz, Ockular, Turkeyin March and May 2010 was of following species; *Grimmia anodon* Bruch and Schimp, *Tortella turtuosa*(Hedw.) Limpr, *Syntrichia ruralis* (Hedw FWeber) and D.Mohr, *Pleurochaete squarrosa*(Brid.).Lindb, *Bryum capillarye* Hedw, and *Orthotrichum rupestre* Schleichex Schwagr[24].Pleurocarp mosses collected from the province of Zonguldak, Turkey including *Platyhypnidium riparioides* (Hedw.) Dixon, *Leucodon sciuroides*(Hedw.)Schwagr, *Hypnum cupressiforme* Hedw, *Homalothecium sericeum* (Hedw.)Br. Eur.,and *Anomodon viticulosus*(Hedw.) Hook and Taylor.[25]

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Musci collected from Mount Sundiken in 2007were *Funaria hygometrica* Hedw, *Hypnum cupressiforme*, *Hypnum imponen s*Hedw, *Polytrichum juniperinum* Hedw, and *Tortella tortuosa*(Hedw.) Limpr. [26]while mosses collected from various habitats of soil, stones, stems, trees, and sedimentary rocks in Sebinkarahisar Turkeyin March 2009were *Tortula muralist* Hedw, *Homalothecium lutescens* (Hedw.) H.Rob, *Hypnum cupressiforme* Hedw, and *Pohlianutans* (Hedw.)Lindb.[27]

Results of musci collection in November 2007 in Vancouver, British Columbia were *Sphagnum palustre*, *Bartramia pomiformis*, *Leucolepsis acanthoneuron*, *Hyclomium splendens*, *Atricum selwynii*, *Polytrichastrum Alpinum*[28]. Mosses collected from Belgrade Serbia were *Atrichum undulatum* and *Physcomitrella patens*[29]while mosses collected from the Belgrade, Serbia in November 1994 were *Fontinalis antipyretica*Hedw.,*Hypnum cupressiforme* Hedw, and *Ctenidium molluscum* (Hedw.) Mitt.[30]

Mosses collected from Nainital including *Leucodon secundus* Schwager, *Rhodobryum roseum* (Schimp.) Limpr, *Plagiomimnium integrum*(Hedw.), *Timminiella anomala*(De Not.) Limpr, and *Brachythecium buchananii*.[31] Mosses sample collected from Serbia were consisted of *Pleurozium schreberi* (Willd exBrid.) Mitt, *Palustriella commutate* (Hedw.)Ochyra, *Homolothecium phippeanum* (Spruce) Schimp, *Anomodon attenuatus*(Hedw.) Huebener, *Rhytidium rugosum* (Hedw.) Kindb, *Hyclomium splendens* (hedw.)Schimp, *Dicranum scoporium* (hedw.), and *Leucobryum glaucum*(hedw).[32]

Musci collected from Mukteswar, Kumaon hill, India in November 2007 including *Thuidium delicalutum, Thuidium cymbifolium, Bryum cellulare, Bryum argentium, Racomitrium crispulum*[33], meanwhile musci collected from Madrid, Spain were comprised of *Bartramia pormiformis, Dicranum scoparium, Plagiomimnium cuspidatum, Plagiomimnium sffine,* and *Hedwigia ciliate.*[34]

Mosses diversity from Cangar forest exploration results showed difference compared to mosses species found elsewhere. Similarity was only found in the genu staxon level, for example *Thuidium*, *Barbules*, and *Hyophylla*. This study was expected to provide more information about the musci biodiversity endemic to Indonesia, so it can be a database for the future development of natural resource for medicinal purpose towards better public health.

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Indonesia, so it can be a database for the future development of natural resource for medicinal purpose towards better public health.

Conclusion

Musci species diversity from Cangar forest, Batu exploration based morphological and anatomical characters resulted in 22species of mosses. Seven species Musci was found on soil, 11 species on trees, and4 species on stones.

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