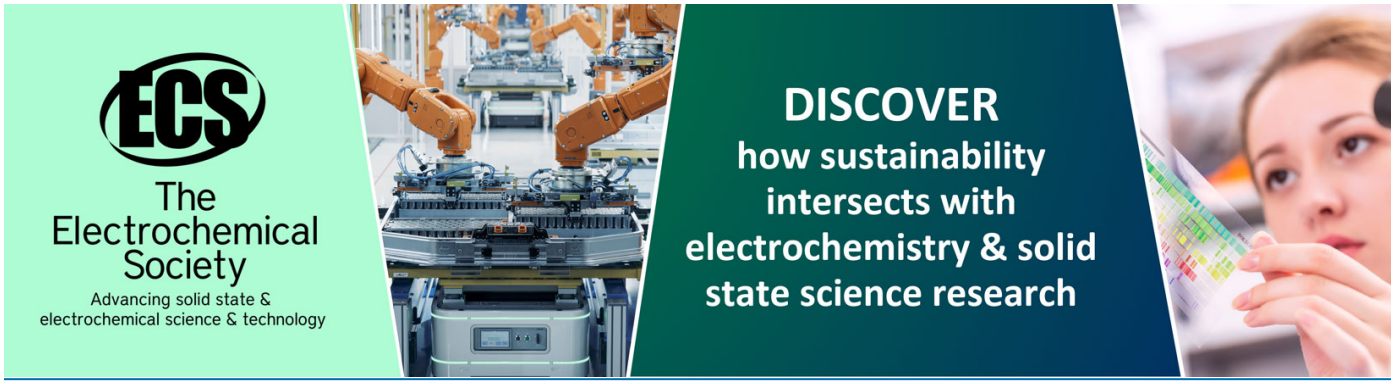
Mosses diversity from Lombok island, West Nusa Tenggara



Mosses diversity from Lombok island, West Nusa Tenggara

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Abstract. Lombok is a part of the Lesser Sunda Islands located in the West Nusa Tenggara Province. The diversity of mosses reported by Touw in 1992. The mosses research at surrounding Rinjani National Park was be conducted. The result reported 72 species of mosses including 46 genera and 21 families. The higher of mosses diversity is Meteoriaceae. More than 27% of mosses at the site is suggested as new records from Lombok.

1. Introduction

Lombok is one island of the Lesser Sunda Islands located in West Nusa Tenggara province. This island has some conservation areas and one of them is Rinjani Mount National Park. This conservation area located at 116°21'30" - 116°34'15" E and 8°18'18" - 8°32'19" S. The topography is mountainous with varying land slopes: flat, bumpy, hilly to mountainous, with an area of 40,000 Ha and altitude 500 - 3726 m asl (top of Rinjani Mount). The annual rainfall up to 2000 ml. Three types of ecosystem in this national park were tropical lowland rain forest, sub mountain tropical rain forest and sub alpine vegetation. Rinjani Mount National Park is a beautiful forest and as sources of germplasm, research, education and tourism [1].

Plant diversity researches on this island have been carried out including mosses group. Some researchers have conducted moss inventories on this island such as Elbert in 1909, Balasz in 1965 and Touw & Snoek in 1986. The total collections are 150 species [22]. The interesting of the occurrence of long-time gaps has not been rediscovered of mosses in this island (around 29 years) then it need to re-collect on old site and new sites to increase of mosses diversity in this island.

2. Materials and Methods

2.1. Research areas

The inventory was carried out in some places surrounding Rinjani National Park at April to May 2015. The areas were Kembang Kuning Resort Forest, Jeruk manis, Sikur, East Lombok; Aikmal Resort Forest, East Lombok; Forest in surrounding hot spring water at Sebau, East Lombok and surrounding Pusuk Mount natural reserves forest at West Lombok.

2.2. Method

The field study method has refered to the Rugayah *et al.* (2004) and Cornard (1982). Identification of all samples were done in the Herbarium Bogoriense. Some references used to identify such as Mosses of the Philippines (Bartram, 1939), A Handbooks of Malesian Mosses volume 1, 2,3 (Eddy, 1988;

1990; 1996), Moss and Liverworts of Hongkong volume 1&2 (So, 1995; Zhu & So, 1996) and the herbarium Bogoriense mosses specimen collections. The distribution tracking from all mosses in research areas were done manually or digitally to find out the taxonomic status. All moss collections from research areas are processed as herbarium collections after data collection, labeling and packing, then are stored in the Herbarium Bogoriense.

3. Results and Discussion

The mosses inventory from research areas was collected about 106 specimen samples and were identified as 72 species, 46 genera and 21 families. The highest moss diversity in the research areas is Meteoriaceae (Figure 1) and *Meteorium polytrichum* Dozy & Molk. is the common species which hanging on twigs in the forest at 800-1550 m asl. The Meteoriaceae is a group of 'pleurocarpus' moss, creeping or hanging on trees in the forest. According to Streiman [22], this family contain 21 genera and 300 species as epiphytes in moist and dense forests at the tropics, subtropics and temperate regions. Meteoriaceae along with Plagiochillaceae, Pterobryaceae, Neckeraceae, Phyllogoniaceae and Lejeuneaceae which known as scio-hygrophilous mosses were found the lowest branches of trees [19]. In this research, members of this family were found hanging on the lowest branches of pine trees in the humid forest at 1146 m asl. The environmental condition of this forest is suitable environment for growth and development of the Meteroriaceae so that its presence in the forest is abundant.

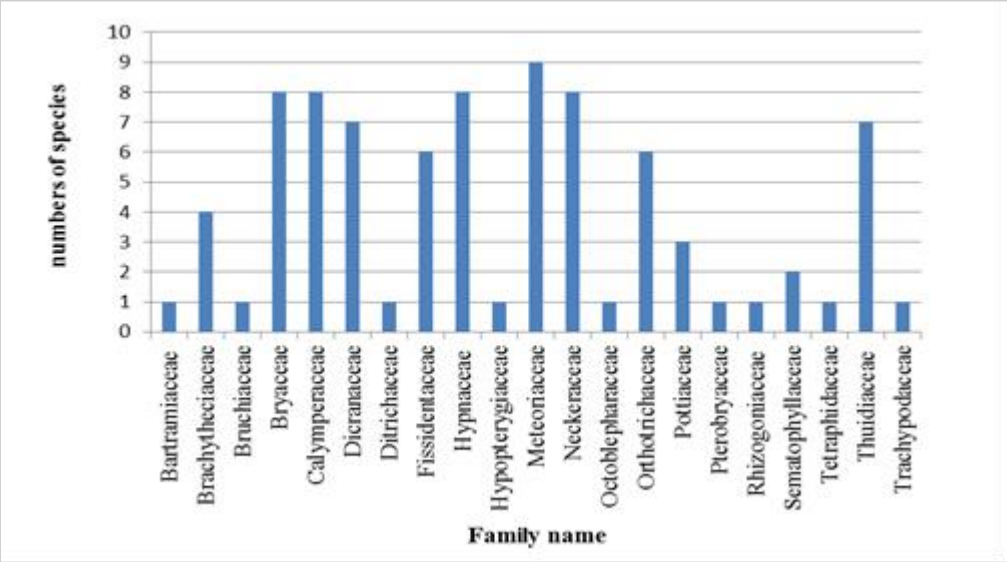

Figure 1. Mosses diversity from research areas based on family group.

Mosses diversity from Lombok island were recorded about 150 species by Touw (1992) based on specimen collections from Elber in 1909, Balasz in 1965, Touw &Snoek in 1986. Herbarium Bogoriense is deposited 21 species of mosses from Lombok Island. While the research in 2015 collected about 72 species of mosess from surrounding Rinjani Mount National Park. The compiling of all moss data collections from Lombok Island reported 208 species (Figure 2).

Mosses in Gunung Rinjani National Park has high species diversity because this region has many ecosystem types from lowland tropical rainforests to mountain tropical forests and has relatively undisturbed primary forests that are suitable as habitat for growth and development of moss. Gradstein (2001) reports that the diversity of bryophyte in the tropical forests of sub-mountains and mountains is higher compared to lowland tropical forests.

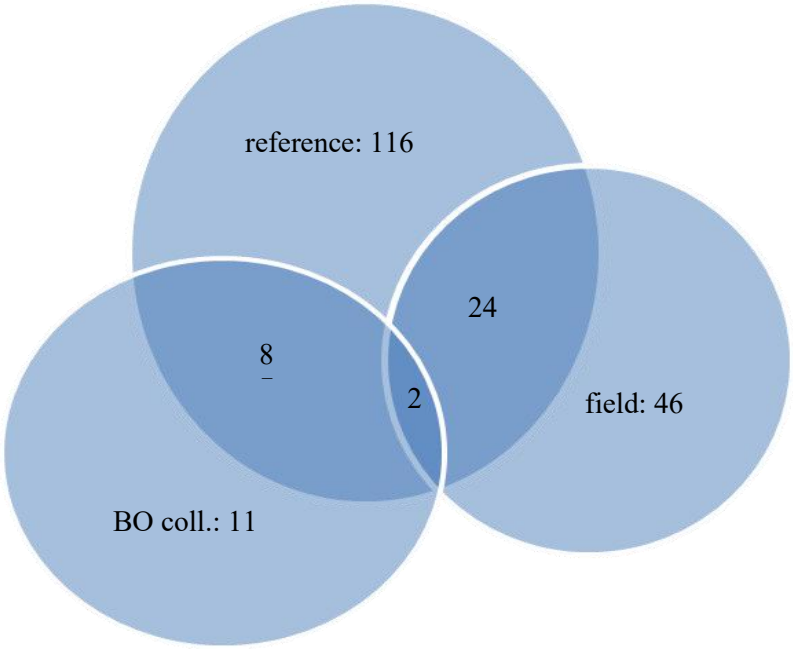

Figure 2. Venn diagram of Lombok mosses diversity, based on data of reference (Tow, 1992), BO collections and research areas.

Based on the Venn diagram (Figure 1), two species of moss (*Aerobryopsis wallichii* and *Pyrrhobryum spiniforme*) were rediscovered at the research areas. *Aerobryopsis wallichii* has a synonym *Aerobryopsis longissima.* It was collected by J. Elber in 1909 (E 1123, 2127B, 2188, 2193 mix) from Rinjani Mount (2400-2650 m asl) and Kembang kerang (1350-2200 m asl). Touw & Snoek also collected it in 1986 (TS 22224) from Tetebatu (700-800 m asl). This research rediscovered it was hanging on twigs in the forest surrounding Jeruk Manis waterfall in Kembang Kuning Resort, Sikur, East Lombok (FIW 4169) and in Pusuk Protected Forest, Sebau, West Lombok (FIW 4289). While *Pyrrhobryum spiniforme* was collected from Pusuk Mount by by J. Elbert in 1909 (600-900 m asl; E. 1852 & 1921) and from Rinjani Mount (1000-2050 m asl) by J.Elbert (E. 2192), Balasz in 1965 (Balasz 47E) and Touw & Snoek in 1986 (TS22359). The rediscovery of both mosses in research areas with a long-time gap (Elbert- Balasz: 56 years; Balasz – Touw &Snoek: 21 years; Tow & Snoek – FIW: 29 years) indicated that the environmental condition in this national park areas are well preserved.

Based on the diagram above (Figure 1), it showed that 57 species (11 species mosses were unpublished and deposited in Herbarium Bogoriense and 46 species from research areas) were proposed as new records for Lombok Island. The appearance of new records from the research areas can be caused by nature and anthropogenic activities. The environment changing is caused by natural disasters such as landslides, the fall of old trees in the forest, the activities of Rinjani Mount (nine times of eruption during 1874-2004) and forest change of the other mount surrounding Rinjani Mount National Park [1]. While anthropogenic changing is caused by the addition of tourism facilities in the Gunung Rinjani National Park area. The nature and anthropogenic changing will have an impact on the changing microclimate. Sonnleitner, et al. (2009) reported that the microclimatic parameters (availability of temperature, relative humidity and light) and phorophyte identities were correlated to the differences of cover, diversity and species composition of bryophyte. Microclimate is also regarded as the major driver of epiphyll distribution [5, 13, 14, 17, 25]. The small environmental changing will

greatly affect on the mosses and other microorganism in its habitat. The addition of moss diversity in these environments can occur due to the moss spores which are small and easily dispersed by the wind. If the spores find a suitable environment, it will germinate and grow into mature moss plants. Likewise, the development of tourism in the national park area such as the addition of tourism supporting facilities will also slightly change the condition of the previous forest.

Table 1. New records of mosses for Lombok island.

Family / Species Name:	Field	Bo Coll.	Loc. Coll.	Date
BARTRAMIACEAE*:*				
1. *Philonotis fontana* (Hedw.) Brid.	√		2	2015
BRACHYTHECIACEAE:				
2. *Eurhynchium striatum* (Schreb. ex Hedw.) Schimp.	√		1&5	2015
BRYACEAE:				
3. *Leptostomum erectum* R. Br.		√	8	1909
4. *Ptychostomum capillare* (Hedw.) D. T. Holyoak. & N. Pedersen	√		6	2015
5. *Trematodon longicollis* Michx.	√		5	2015
CALYMPERACEAE:				
6. *Arthrocormus schimperi* (Dozy and Molk) Dozy and Molk	√		2	2015
7. *Calymperes afzelii* Sw.	√		2	2015
9. *Calymperes boulayi* Besch.	√		2	2015
10. *Calymperes palisotii* Schwägr.	√		1	2015
11. *Leucophanes angustifolium* Renauld & Cardot	√		2	2015
12. *Syrrhopodon proliffer* Schwagr.	√		5	2015
13. *Syrrhopodon spiculosus* Hook. & Grev.	√		2	2015
DICRANACEAE:				
14. *Campylopus schmidii* (Müll. Hal.) A. Jaeger		√	8	1909
15. *Campylopus introflexus* (Hedw.) Brid.	√		7	2015
16. *Dicranoloma assimile* (Hampe.) Paris	√		6	2015
17. *Dicranoloma billardieri* (Brid.) Paris	√		1 &4	2015
18. *Leucobryum juniperoideum* (Brid.) Mull. Hall	√		5	2015
19. *Leucoloma molle* (Müll. Hal.) Mitt.	√		5	2015
20. *Microcampylopus khasianus* (Griffths) Giese & J.-P. Frahm		√	8	1909
21. *Pilopogon blumii* Broth		√	8	1909
FISSIDENTACEAE:				
22. *Fissidens anomalus* Mont.	√		1	2015
23. *Fissidens braunii* (Müll. Hal.) Dozy & Molk.	√		2	2015
24. *Fissidens laxus* Sull. & Lesq.	√		2	2015
25. *Fisssidens delicatulus* (Reinw. & Hornsch.) A. Jaeger	√		1	2015

Note: 1= Tetebatu, East Lombok; 2: Kembang Kuning Resort, Jeruk Manis, Sikur, East Lombok; 3: Aikmal Resort, East Lombok; 4: Alor Gedang, East Lombok; 5: Sebau, West Lombok; 6: Pusuk Mount., West Lombok; 7: Joben, Rinjani National Park, Lombok; 8: Rinjani Mount.

Table 1 (Continue)

Family / Species Name:	Field	Bo Coll.	Loc. Coll.	Date
FUNARIACEAE:				
26. *Funaria hygrometrica* var *clavescens (*Schwaegr.) Mont.		√	8	1909
GRIMMIACEAE:				
27. *Rhacomitrium hypnoides* Lindb.		√	8	1909
HYPNACEAE:				
28. *Ectropothecium dealbatum* (Reinw. & Hornsch.) A. Jaeger	√		1	2015
29. *Ectropothecium ichnotocladum* (Mull. Hal.) A. Jaeger	√		2	2015
30. *Ectropothecium falciforme* Jaeg		√	8	1909
31. *Isopterygium minutirameum* (Müll. Hal.) A. Jaeger	√		2	2015
32. *Vesicularia montagnei* (Schimp.) Broth.	√		2	2015
METEORIACEAE:				
33. *Aerobryopsis subleptostigmata* Broth. & Paris	√		1	2015
34. *Barbella flagellifera* (Cardot) Nog.	√		5	2015
35. *Barbella rufifolioides* (Broth.) Broth.	√		2	2015
36. *Floribundaria pseudofloribunda* M.Fleisch.	√		5&2	2015
37. *Meteorium subpolytrichum* (Besch.) Broth.	√		2	2015
NECKERACEAE:				
38. *Neckera complanata* (Hedw.) Huebener	√		1	2015
39, *Pinatella ambigua* (Bosch & Sande Lac.) M. Fleisch.	√		2	2015
ORTHOTRICHACEAE:				
40. *Macromitrium falcatulum* Müll. Hal.	√		2	2015
41. *Macromitrium fasciculare* Mitt.	√		1	2015
42. *Macromitrium goniorrhynchum* Mitt	√	√	8	1909
43. *Macromitrium orthostichum* Nees ex Schwägr.	√		3	2015
44. *Macromitrium schimidii* Mull. Hal.	√		2	2015
45. *Orthotrichum schoddei* Lewinsky	√		3	2015
POTTIACEAE:				
46. *Barbula laxiretis* Broth.		√	8	1909
47. *Barbula unguiculata* Hedw.	√		6	2015
48. *Hymenostylium luzonense* Broth. var *minus* Broth		√	8	1909
PTEROBRYACEAE:				
49. *Calyptothecium phyllogonioides* Nog. & X.J. Li	√		3&6	2015
SEMATOPHYLLACEAE:				
50. *Acroporioum fuscoflavum* (Paris) Broth.	√		2	2015
THUIDIACEAE:				
51. *Herpetineuron toccoae* (Sull. & Lesq.) Cardot	√		2	2015
52. Thuidium assimile (Mitt.) A. Jaeger	√		2	2015
53. *Thuidium delicatulum* (Hedw.) Schimp.	√		5	2015
54. *Thuidium investe* (Mitt.) A. Jaeger	√		2	2015
55. *Thuidium meyenianum (*Hampe) Dozy & Molk.	√		1	2015

Note: 1= Tetebatu, East Lombok; 2: Kembang Kuning Resort, Jeruk Manis, Sikur, East Lombok; 3: Aikmal Resort, East Lombok; 4: Alor Gedang, East Lombok; 5: Sebau, West Lombok; 6: Pusuk Mount., West Lombok; 7: Joben, Rinjani National Park, Lombok; 8: Rinjani Mount.

Tabel 1 (Continue)

Family / Species Name:	Field	Bo Coll.	Loc. Coll.	Date
56. *Thuidium tamariscellum* (Müll. Hal.) Bosch & Sande Lac.	√		2	2015
TRACHYPODACEAE:				
57. *Trachypodopsis serrulata* (P. Beauv.) M. Fleisch.	√		2	2015

Note: 1= Tetebatu, East Lombok; 2: Kembang Kuning Resort, Jeruk Manis, Sikur, East Lombok; 3: Aikmal Resort, East Lombok; 4: Alor Gedang, East Lombok; 5: Sebau, West Lombok; 6: Pusuk Mount., West Lombok; 7: Joben, Rinjani National Park, Lombok; 8: Rinjani Mount.

Mosses are a simplest group of chlorophyllous plants which grow as epiphyte in a variety of substrates. Mosses in these research areas were found growing on various substrate such as soil, rocks, dead log, decaying wood, and tree trunks. Based on observation data at these research areas, the tree trunk is the best substrate for moss 49.5 % (Figure 3).

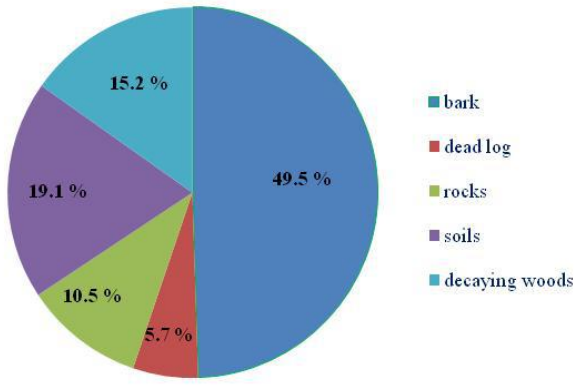

Figure 3. Percentage of mosses on

The tree trunks with over grown of moss are
Smith (1982) and Bates (2008) reports. Phorophyte
and establishment of epiphyllous communities [5
generally have rough skin surfaces or cracks along
place to descend of mosses spore and rainwater
conditions are suitable and did not find inhibiting fa
24]. Bark structure and microclimate were identifie
within the forest. Due to the lack of a protective cu
conditions [9, 11, 27]. The part of stem that overgr
because moss requires light for the photosynthesi
moderate light levels [12] such as the small gap in f

4. Conclusion

Mosses in Gunung Rinjani National Park has high species diversity with 210 species.The long-time gap not re-collected of the moss diversity in the Gunung Rinjani National Park has an impact on the addition of diversity, 42 species were found in the research areas as new records. *Aerobryopsis walichii* and *Pyrrhobryum spiniforme* which were rediscovered at the research areas showed that forest management in the Gunung Rinjani National Park area is well preserved.

5. References

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