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**Checklist**


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## A Checklist of mosses from Golden Hope Oil Palm Plantation and surrounding areas, Tawau, Sabah, East Malaysia

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**ABSTRACT.** A total of 56 taxa in 31 genera and 14 families of mosses were collected from Golden Hope Oil Palm Plantation area. This represents 9.3% of the 597 species of mosses reported for Sabah and 7.7% of the 724 species reported for Borneo. *Acroporium convolutum* var. *horridulum* is a new record for Borneo, whereas *Ectropotheciella distichophylla* is a new record for Sabah. The largest family is Calymperaceae with six genera and 14 species, followed by Hypnaceae with four genera and nine species. Oil palm plantation recorded 25 species of mosses in 16 genera, while its surrounding natural areas recorded 42 species in 25 genera.

### INTRODUCTION

There are few reports of mosses in lowland areas in Sabah. Suleiman *et al.* (2003) listed 47 species in 24 genera and 12 families from Lower Kinabatangan. In the present study, one species is shown to be new to Borneo and one species new to Sabah. This shows that lowland areas in the state of Sabah harbour part of the richness of the bryoflora of Borneo.

### MATERIALS AND METHOD

A general survey was conducted in February of 2008 in a number of oil palm plantations and

vicinity in five estates (Binuang, Mongkok, Mostyn, Sungang, and Table) located in two districts (Kunak and Tawau) in Sabah (Table 1; Figure 1). Habitat information for each of the moss specimens collected was recorded, and the mosses identified were later grouped in two categories, namely, oil palm plantation and surrounding areas, for a comparison of species association and diversity (see Table 2; Appendix 1).

### RESULTS

In spite of the extensive cultivated areas in Malaysia planted with oil palms, this report is the first moss checklist prepared for oil palm plantation in the country. To date, there were 25 species of mosses collected from the oil palm plantations located in several estates in Kunak and Tawau districts (Table 2). The most common species found on the plantation floor is *Vesicularia dubyana*, whereas *Syrrhopodon ciliatus* and *Arthrocnemum schimperi* are among the commonest mosses on oil palm trunks.

Additionally, there were 42 species of mosses collected from the natural areas surrounding the plantations (Table 2). The figure is nearly twice the number of moss taxa found in the man-made oil palm plantation (Table 2). Of these, *Acroporium convolutum* var. *horridulum*, *Acroporium johannis-winkleri*, *Ectropotheciella distichophylla*, *Fissidens*

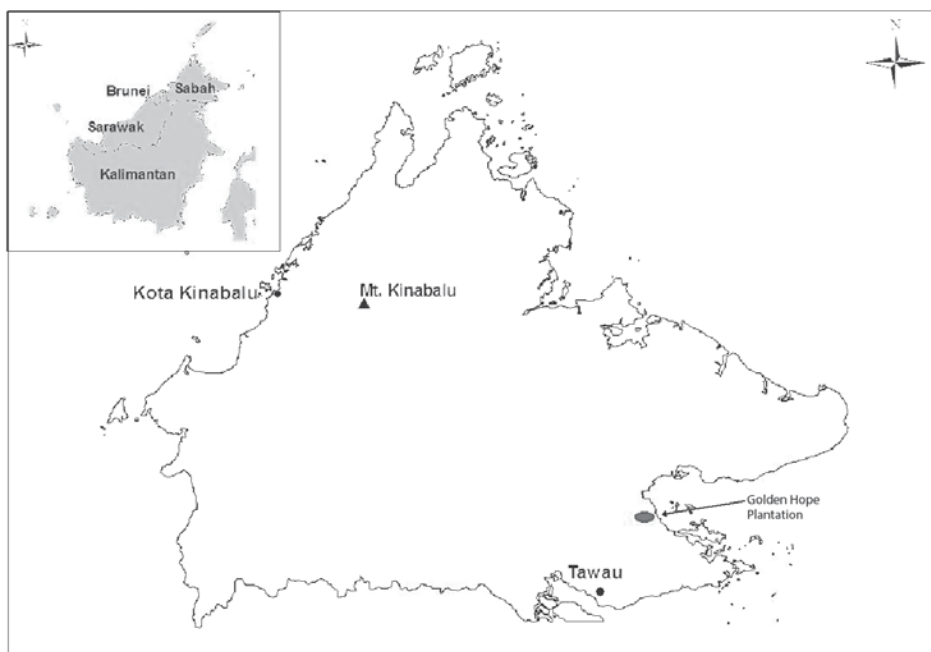
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*Keywords:* checklist, mosses, Golden Hope, oil palm, plantation.

**Table 1.** Collection localities, dates and numbers.

Collection Number	Date	Locality
2435-2440	19 February 2008	Kunak District, Mostyn Estate, around rest house.
2441-2478	19 February 2008	Kunak District, Mostyn Forest Reserve.
2479	19 February 2008	Kunak District, Mostyn Estate, around water spring.
2480-2484	19 February 2008	Kunak District, Madai-Baturong Forest Reserve.
2485-2502	20 February 2008	Kunak District, Mostyn Estate, oil palm plantation.
2503-2517	21 February 2008	Tawau District, Table Estate, base of Bombalai Hill.
2518-2532	22 February 2008	Tawau District, Table Estate, Kg. Indah, Somel Water Spring.
*113-124	25 February 2008	Kunak District, Binnang Estate, Sungang Estate & Mongkok Estate.
*125	26 February 2008	Kunak District, Mostyn Estate.

\* Collected by Dunstan Polus Masundang

**Figure 1.** Map of Sabah showing Golden Hope Oil Palm Plantation.

**Table 2.** Sumamary of mosses found in oil oil palm plantation and its surrounding areas.

No.	Moss species Substrate	Oil palm plantation		Surrounding areas	
		Oil palm trunks	Other substrates	Tree trunks	Other substrates
1	<i>Acroporium convolutum</i> var. <i>horridulum</i>		+		
2	<i>Acroporium johannis-winkleri</i>		+		
3	<i>Aequatoriella bifaria</i>				+
4	<i>Arthrocormus schimperi</i>	+			
5	<i>Bryum apiculatum</i>				+
6	<i>Bryum</i> cf. <i>coronatum</i>		+		+
7	<i>Callicostella papillata</i>		+		+
8	<i>Calymperes afzelii</i>			+	
9	<i>Calymperes boulayi</i>				+
10	<i>Calymperes erosum</i>	+			+
11	<i>Calymperes lonchophyllum</i>			+	+
12	<i>Calymperes porrectum</i>				+
13	<i>Calymperes taitense</i>				+
14	<i>Calymperes tenerum</i>	+			+
15	<i>Chaetomitrium orthorrhynchum</i>			+	
16	<i>Ectropotheciella distichophylla</i>				+
17	<i>Ectropothecium</i> cf. <i>buitenzorgii</i>		+		
18	<i>Ectropothecium</i> sp.1	+			
19	<i>Ectropothecium</i> sp.2	+			
20	<i>Exostratum blumei</i>				+
21	<i>Fissidens ceylonensis</i>		+		+
22	<i>Fissidens crassinervis</i>		+		
23	<i>Fissidens crispulus</i> var. <i>crispulus</i>		+		
24	<i>Fissidens crispulus</i> var. <i>robinsonii</i>				+
25	<i>Fissidens</i> cf. <i>hollianus</i>				+
26	<i>Fissidens nobilis</i>				+
27	<i>Fissidens geminiflorus</i>				+
28	<i>Fissidens zollingeri</i>				+
29	<i>Himantocladium cyclophyllum</i>				+
30	<i>Homaliodendron microdendron</i>			+	
31	<i>Hyophila involuta</i>				+
32	<i>Isopterygium albescens</i>		+		+
33	<i>Isopterygium minutirameum</i>			+	
34	<i>Isopterygium</i> sp.1				+
35	<i>Leptotrichella miquelina</i>				+
36	<i>Leucophanes candidum</i>	+			
37	<i>Leucophanes glaucum</i>	+		+	
38	<i>Leucophanes octoblepharoides</i>	+		+	+
39	<i>Meiothecium microcarpum</i>			+	
40	<i>Mitthyridium flavum</i>			+	
41	<i>Mniomalia semilimbata</i>				+
42	<i>Neckeropsis gracilentia</i>			+	
43	<i>Neolindbergia rugosa</i>			+	
44	<i>Octoblepharum albidum</i>	+			

cont. Table 2.

No.	Moss species Substrate	Oil palm plantation		Surrounding areas	
		Oil palm trunks	Other substrates	Tree trunks	Other substrates
45	<i>Pelekium velatum</i>		+		+
46	<i>Philonotis hastata</i>				+
47	<i>Philonotis</i> sp.1		+		
48	<i>Pogonatum piliferum</i>		+		
49	<i>Syrrhopodon ciliatus</i>	+			
50	<i>Syrrhopodon parasiticus</i>			+	
51	<i>Thuidium cymbifolium</i>				+
52	<i>Thuidium plumulosum</i>				+
53	<i>Taxithelium</i> cf. <i>vernieri</i>				+
54	<i>Trichosteleum stigmosum</i>		+		
55	<i>Vesicularia dubyana</i>		+		+
56	<i>Vesicularia miquelii</i>		+		+
<b>Total</b>		<b>10</b>	<b>15</b>	<b>12</b>	<b>32</b>
<b>TOTAL NUMBER OF SPECIES</b>		<b>25</b>		<b>42</b>	

*nobilis*, *Exostratum blumei*, *Mniomalia semilimbata* and *Neolindbergia rugosa* are species of primary lowland rain forest in the region, and the rest are common species in disturbed and semi-open lowland tropical forests.

In summary, the total moss taxa documented from the Golden Hope Oil Palm plantation areas represents 9.3% of the 597 species of mosses reported for Sabah and 7.7% of the 724 species reported for Borneo (Suleiman *et al.*, 2006). Furthermore, the largest family is Calymperaceae with six genera and 14 species, followed by Hypnaceae with four genera and nine species.

Two submerged species were collected at Somel Water Spring, namely *Vesicularia miquelii* and *Fissidens geminiflorus*. This is an interesting find as true aquatic mosses are rare in Borneo. Mosses are becoming popular these days as aquarium plants in Southeast Asia (Tan & Loh, 2005). A good number of species of *Fissidens* and *Vesicularia* are sold

in aquarium shops in Singapore, Japan, Europe and North America for use to decorate fish tanks and to do aquascape design.

## DISCUSSION

Table 2 shows that there are more diversity of mosses found in the natural areas surrounding the oil palm plantations. One can presume that the greater diversity is due to the still primary nature of the remnant forests left after the plantation establishment. It remains to be seen if the high diversity of mosses surviving in the surrounding natural areas of the oil palm plantation will persist over the years of continued disturbance by man.

Undoubtedly, the trunk of oil palms with its persistent leaf bases left attached after the cutting of the fronds provides a unique habitat above the ground for plants to grow. In a previous study of pteridophytic plant association found in the leaf pockets of oil palm trunks in plantations in Peninsular Malaysia,

there was a constant association of fern taxa, which include *Nephrolepis auriculata*, *Goniophlebium percussum* and *Davallia denticulata* (Faridah *et al.*, 2003). Likewise, in the present survey, it appears that there is also a constant association of leucobryoid moss species growing epiphytically and in abundance on the trunks of oil palms, especially in leaf pockets. They include *Arthrocormus schimperi*, *Octoblepharum albidum*, three species of *Leucophanes*, and other mosses of less frequency, such as *Syrrhopodon ciliatus* and *Calymperes erosum*. The last two mentioned mosses have built in dead cells or cancellinae in the leaf. The presence of constant association of leucobryoid and morpho-anatomically related mosses on the trunk and leaf pockets of oil palms may indicate an environment rich in humus substrate, but lacking regular supply of water.

#### ACKNOWLEDGEMENTS

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### APPENDIX 1. The list of mosses collected and identified

Presented below is a list of the mosses collected in the present study with their family classification. All the specimens reported are deposited at the BORNEENSIS Herbarium (BORH) of the Institute for Tropical Biology and Conservation, with duplicates sent to SING Herbarium. An asterisk (\*) indicates a new species record for Sabah and double asterisks (\*\*\*) indicates a species new to Borneo.

#### POLYTRICHACEAE

*Pogonatum piliferum* (Griff.) Mitt.

On soil, 200m, *M.Suleiman & D.P.Masundang* 2491.

#### FISSIDENTACEAE

*Fissidens ceylonensis* Dozy & Molk.

On rock and soil, 200m, *M.Suleiman & D.P.Masundang* 2448, 2488.

*Fissidens crassinervis* Sande Lac.

On Soil, 200m, *M.Suleiman & D.P.Masundang* 2493.

*Fissidens crispulus* Brid. var. *crispulus*

On rock and rotten log, 270m, *M.Suleiman & D.P.Masundang* 2503a, 2515.

This is the second report for this taxa for Sabah and Borneo (*Suleiman et al.*, 2006).

*Fissidens crispulus* Brid. var. *robinsonii*

(Broth.) Z. Iwats. & Z. H. Li

On cliff and boulder, 200m, *M.Suleiman & D.P.Masundang* 2461, 2463, 2466.

*Fissidens* cf. *hollianus* Dozy & Molk

On rock, 200m, *M.Suleiman & D.P.Masundang* 2452.

*Fissidens nobilis* Griff.

On boulders, 200m, *M.Suleiman & D.P.Masundang* 2473, 2477.

*Fissidens zollingeri* Mont.

On rock, 200m, *M.Suleiman & D.P.Masundang* 2449.

*Fissidens geminiflorus* Dozy & Molk.

Submerged in water spring, 30m, *M.Suleiman & D.P.Masundang* 2529.

#### DICRANACEAE

*Leptotrichella miqueliana* (Mont.) Lindb. ex Broth. [syn. *Microdus miquelianus* (Mont.) Besch.]

On soil of uprooted tree, 200m, *M.Suleiman & D.P.Masundang* 2476.

#### LEUCOBRYACEAE

*Octoblepharum albidum* Hedw.

On oil palm trunk, 90-200m, *M.Suleiman & D.P.Masundang* 2436, 2489, *D.P.Masundang* 113.

#### PHYLLODREPANOPHYLLACEAE

*Mniomalia semilimbata* (Mitt.) Müll.Hal.

On rock, 30m, *M.Suleiman & D.P.Masundang* 2532.

Only two records of occurrence of this interesting species in Sabah in 1916 and 1975 (*Suleiman et al.*, 2006).

#### CALYMPERACEAE

*Arthrocormus schimperi* (Dozy & Molk.) Dozy & Molk.

On oil palm trunk, 270m, *M.Suleiman & D.P.Masundang* 2508.

*Calymperes afzelii* Sw.

On tree trunk, 200m, *M.Suleiman & D.P.Masundang* 2475.

*Calymperes boulayi* Besch.

On rock and concrete, 30m, *M.Suleiman & D.P.Masundang* 2522a.

*Calymperes erosum* Müll.Hal.

On rock and oil palm trunk, 200m, *M.Suleiman & D.P.Masundang* 2496, *D.P.Masundang* 115.

*Calymperes lonchophyllum* Schwäegr.

On tree trunk and cliff, 200m, *M.Suleiman & D.P.Masundang* 2444, 2458.

*Calymperes porrectum* Mitt.

On boulder, 200m, *M.Suleiman & D.P.Masundang* 2472.

*Calymperes tahitense* (Sull.) Mitt.

On cliff and decaying log, 200m, *M.Suleiman & D.P.Masundang* 2456, *D.P. Masundang* 121.

*Calymperes tenerum* Müll.Hal.

On oil palm trunk and rock, 30-200m, *M.Suleiman & D.P.Masundang* 2500, 2527.

*Exostratum blumei* (Nees ex Hampe) L.T.Ellis

On decaying log, 200m, *D.P.Masundang* 122.

*Leucophanes candidum* (Schwägr.) Lindb.

On palm trunk, 270m, *M.Suleiman & D.P.Masundang* 2509.

*Leucophanes glaucum* (Schwägr.) Mitt.

On oil palm and ornamental palm trunks, 200m, *M.Suleiman & D.P.Masundang* 2437, 2499.

*Leucophanes octoblepharoides* Brid.

On wooden staircase, 200m, *M.Suleiman & D.P.Masundang* 2441.

*Mitthyridium flavum* (Müll.Hal.) H.Rob.

On tree buttress, 200m, *M.Suleiman & D.P.Masundang* 2454.

*Syrrhopodon ciliatus* (Hook.) Schwägr.

On oil palm trunk, 200-270m, *M.Suleiman & D.P.Masundang* 2485, 2507.

*Syrrhopodon parasiticus* (Brid.) Besch.

On oil palm trunk, 200m, *M.Suleiman & D.P.Masundang* 2438.

#### POTTIACEAE

*Hyophila involuta* (Hook.) A.Jaeger

On rock and concrete, 30m, *M.Suleiman & D.P.Masundang* 2522b.

#### BRYACEAE

*Bryum apiculatum* Schwägr.

On soil and concrete, 30m, *M.Suleiman & D.P.Masundang* 2518, 2521.

*Bryum* cf. *coronatum* Schwägr.

On soil and rock, 30-200m, *M.Suleiman & D.P.Masundang* 2495, 2502, 2525.

#### BARTRAMIACEAE

*Philonotis hastata* (Duby) Wijk & Margad.

On boulder, 200m, *M.Suleiman & D.P.Masundang* 2479.

*Philonotis* sp.1

On soil, 270m, *M.Suleiman & D.P.Masundang* 2512.

#### PTEROBRYACEAE

*Neolindbergia rugosa* (Lindb.) M.Fleisch.

On tree buttress, 200m, *M.Suleiman & D.P.Masundang* 2469.

#### NECKERACEAE

*Himantocladium cyclophyllum* (Müll.Hal.) M.Fleisch.

On cliff and rock, 30-200m, *M.Suleiman & D.P.Masundang* 2460, 2465, 2531.

*Homaliodendron microdendron* (Mont.) M.Fleisch.

On tree buttress, 200m, *M.Suleiman & D.P.Masundang* 2470.

*Neckeropsis gracilentata* (Bosch. & Sande Lac.) M.Fleisch.

On tree trunk, 200m, *D.P.Masundang* 124.

#### HOOKERIAACEAE

*Callicostella papillata* (Mont.) Mitt

On rock and soil, 200-270m, *M.Suleiman & D.P.Masundang* 2478, 2483, 2510.

*Chaetomitrium orthorrhynchum* (Dozy & Molck.) Bosch & Sande Lac.

On tree trunk, 200m, *D.P.Masundang* 120a.

**THUIDIACEAE**

*Aequatoriella bifaria* (Bosch & Sande Lac.) Touw  
On boulder, 200m, *M.Suleiman & D.P.Masundang*  
2467, 2468.

*Pelekium velatum* Mitt.  
On rotten wood and branch, 200-270m,  
*M.Suleiman & D.P.Masundang* 2471, 2517.

*Thuidium cymbifolium* (Dozy & Molk.) Dozy  
& Molk.  
On decaying stump, 200m, *D.P.Masundang* 123.

*Thuidium plumulosum* (Dozy & Molk.) Dozy  
& Molk.  
On cliff, 200m, *M.Suleiman & D.P.Masundang*  
2459.

**SEMATOPHYLLACEAE**

\* \* *Acroporium convolutum* (Bosch & Sande  
Lac.) M.Fleisch. var. *horridulum* (Bartr.)  
B.C.Tan, T.J. Kop. & D.H. Norris  
On rock, 270m, *M.Suleiman & D.P.Masundang*  
2506.  
This species was known previously as endemic  
to New Guinea (Tan *et al.*, 2007).

*Acroporium johannis-winkleri* Broth.  
On rock, 200m, *M.Suleiman & D.P.Masundang*  
2492.

*Meiothecium microcarpum* (Hook.) Mitt.  
On palm trunks, 200m, *M.Suleiman &*  
*D.P.Masundang* 2435, 2440.

*Taxithelium* cf. *vernieri* (Dubby) Besch.  
On rock, 200m, *M.Suleiman & D.P.Masundang*  
2455a.

*Trichosteleum stigmosum* Mitt.  
On fungi (*Ganoderma*), 200m, *M.Suleiman &*  
*D.P.Masundang* 2490a.

**HYPNACEAE**

\* *Ectropotheciella distichophylla* (Hampe) M.  
Fleisch. On cliff, 200m, *M.Suleiman &*  
*D.P.Masundang* 2462.

*Ectropothecium* cf. *buitenzorgii* (Bel.) Mitt.  
On soil, 270m, *M.Suleiman & D.P.Masundang*  
2514.

*Ectropothecium* sp.1  
On oil palm trunk, 270m, *M.Suleiman &*  
*D.P.Masundang* 2516.

*Ectropothecium* sp.2  
On base of oil palm, 200m, *M.Suleiman &*  
*D.P.Masundang* 2497.

*Isopterygium albescens* (Hook.) Schwägr.  
On *Ganoderma* sp. and rotten wood, 200m,  
*M.Suleiman & D.P.Masundang* 2445, 2453,  
2490b.

*Isopterygium minutirameum* (Müll.Hall.)  
A.Jaeger  
On palm buttress and tree trunk, 200m,  
*M.Suleiman & D.P.Masundang* 2439.

*Isopterygium* sp.1  
On rock and climber, 180-200m, *M.Suleiman &*  
*D.P.Masundang* 2455b, *D.P.Masundang* 125.

*Vesicularia dubyana* (Müll.Hal.) Broth.  
On wall of water spring reservoir, soil, rotten oil  
palm petiole and boulder, 30-220m, *M.Suleiman*  
& *D.P.Masundang* 2482, 2494, 2520, 2528,  
2530.

The last report of this species in Sabah was 92  
years ago (Suleiman *et al.*, 2006) although it is  
a common lowland species. It is very common  
in the oil palm plantations.

*Vesicularia miquelii* (Sande Lac.) M.Fleisch.  
On submerged concrete in water spring and  
rotten twigs, 30-270m, *M.Suleiman &*  
*D.P.Masundang* 2504, 2519.

This is the second report of the species in  
Sabah; first report was in 1916 (Suleiman *et al.*,  
2006).