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A new species, *Bryobrothera tambuyukonensis* (Daltoniaceae, Bryopsida), from Sabah, Borneo Island

HIROYUKI AKIYAMA[1] & MONICA SULEIMAN[2]

[1]*Museum of Nature and Human Activities & Phylogenetic Division/ Institute of Natural and Environmental Science, Hyogo Prefectural University, Yayoigaoka-6, Sanda, Hyogo 669-1546, Japan*

[2]*Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu, Sabah, Malaysia.*

Abstract

We report a new species *Bryobrothera tambuyukonensis*, based on the specimens collected in Sabah, Borneo Island. Phylogenetic analyses with plastid (*rps*4 and *trn*L-F) and mitochondrial (*nad*5) genes along with a number of morphological features (for example, undulate lamina, oblong-lanceolate leaves with a single strong costa reddish brown in color, and thick-walled and porose laminal cells) confirmed its distinctiveness from *B. crenulata* and also close relationship to the elimbate group comprised of *Adelothecium bogotense* and *Benitotania elimbata*.

Key words: mosses, *nad*5, phylogeny, *rps*4, *trn*L-F

Introduction

Mount Tambuyukon (2570 m) in Kinabalu Park (Sabah, Malaysia) is the largest ultramafic mountain on Borneo Island and quite rich in plant species (Van der Ent *et al.*, 2014). During a field survey carried out on this mountain in August 2008, the junior author collected a curious moss in a mossy forest looking quite similar to *Benitotania elimbata* H.Akiyama *et al.* (2003: 456), formerly reported from Kinabalu Park (Akiyama *et al.* 2003). The plants were collected again during a scientific expedition to Sungai Imbak Forest Reserve (Sabah, Malaysia) in April 2014. The second locality is also an ultramafic outcrop. The highest point of this outcrop is only 1460 m, but due to compression effect of forest zones on a small mountain (Richard 1996, Van der Ent *et al.* 2014), a mossy forest developed at a lower elevation even as low as 1100 m (Suleiman *et al.* 2011) and the plants were found in this kind of forest.

External morphology of the plants showed several different features from those expressed in plants of *Benitotania* Akiyama *et al.* (2003: 454), *Bryobrothera* Thériot (1921: 26)., and *Adelothecium* Mitten (1869: 391)., all of which have been suggested to form a well-supported monophyletic clade by phylogenetic analyses using molecular markers (Pokorny *et al.* 2012). Denticulate upper leaf margins and a strongly undulate upper leaf lamina are the most distinctive characteristics and are quite different from the three genera in these features. Therefore, we examined its identity using molecular markers as well as detailed morphological comparisons described below.

Material and Methods

Taxon sampling

In order to settle the systematic position of the present moss, we carried out phylogenetic analyses using *rps*4 and *trn*L-F sequences from chloroplast DNA and *nad*5 from mitochondrial DNA. We included in our analyses other members of the Hookeriales, especially other members of the family Daltoniaceae on the basis of previous phylogenetic analyses (Ho *et al.* 2012, Pokorny *et al.* 2012). Three taxa of the Hypopterygiaceae, i.e., *Cyathophorum bulbosum* (Hedwig 1801: 43) Müller (1850: 14), *Hypopterygium tamarisci* (Hedwig 1801: 212) Müller (1850: 8), and *Lopidium plumarium* (Mitten 1869: 329) Hampe (1879: 162) were used as outgroup terminals. The specimens used in the analysis and their accession numbers are listed in Appendix 1. As for the target taxon, we tried to extract DNA from those collected at different localities, but were able to obtain DNA only from a single sample.

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Interestingly, this species was not found at the Silau-Silau Trail in the vicinity of the Headquarter office of Kinabalu Park or at the summit zone of Mount Alab where *B. elimbata* thrives. Neither of these sites is ultramafic.

Keys to *Bryobrothera tambuyukonensis* and related species

1. Inner cortical cells of stems large and thin-walled and outer ones small and thick-walled. Gemmae on reduced axillary branches. Axillary hairs 5–10-celled, with a hardly differentiated basal cell (rarely with single, slightly pigmented basal cell). Central and South America, and Africa (Tanzania and Madagascar) ..... *Adelothecium bogotense*

- Cortical cells of stems small and thick-walled throughout. Gemmae on reduced axillary branches absent (except for rhizoidiform ones reported from *Bryobrothera*). Axillary hairs less than 6-celled, with 1–2 ± pigmented basal cells .....2.

2. Leaves broadly elliptical to obovate or spathulate-obovate, 0.3–0.6 mm long. Rhizoidiform gemmae in leaf axils. Pseudoparaphyllia filamentous, 3-celled. Philippines, Indonesia (Seram), Australia, Solomon Island, New Caledonia, Fiji..... .....*Bryobrothera crenulata*

- Leaves narrowly ovate to lanceolate, usually more than 2 mm long. Gemmae absent. Pseudoparaphyllia linear-lanceolate. Only known from North Borneo .....3.

3. Leaf apex acute, not mucronate. Lamina distinctly undulate in dry and wet conditions. Laminal cells smooth. Leaf margin denticulate above..... *Bryobrothera tambuyukonensis*

- Leaf apex obtuse, mucronate. Lamina plane, never undulate. Laminal cells minutely verrucose. Leaf margin almost entire..... .....*Benitotania elimbata*

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