

# ***Vitalianthus lamyii* (Marchantiophyta: Lejeuneaceae), a new species from the lowland rainforests of Brunei Darussalam**

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**Abstract** – *Vitalianthus* R.M.Schust. & Giancotti (Lejeuneaceae), previously known only from the Neotropics and Southwestern China, is a small genus with three species. A fourth species, *Vitalianthus lamyii*, is newly described based on collections made in lowland rainforests of Brunei Darussalam, Borneo. This is the first record of *Vitalianthus* from Sundaland. A key to species of *Vitalianthus* is provided.

**Borneo / Brunei / Hepaticae / liverwort / new taxon / Sundaland**

## **INTRODUCTION**

Lejeuneaceae is the most species-rich family of liverworts with over 1800 species in about 70 genera (Zhu *et al.*, 2017b). The tropical lowland rainforest is considered a paradise for Lejeuneaceae. The nation of Brunei (Negara Brunei Darussalam), with 60% of its land area still covered by pristine forests, is located on the northwest coast of the island of Borneo, in the heart of the biodiversity hotspots of Philippines, Sundaland and Wallacea (Myers *et al.*, 2000; Zhu *et al.*, 2017b). The island of Borneo was also listed by Tan & Pócs (2000) as one of the eight areas with the highest diversity and endemism of bryophytes. Our field trip to Kuala Belalong Field Studies Centre (KBFSC) in Temburong District of Brunei in December 2015 has resulted in the description of a new species of Lejeuneaceae, *Drepanolejeunea glimeae* R.L.Zhu *et al.* (Zhu *et al.*, 2017a). An examination of the remaining collections in KBFSC reveals that five specimens are assignable to *Vitalianthus* R.M.Schust. & Giancotti, which has never been recorded in Sundaland. *Vitalianthus* is a small, disjunct genus in tropical Asia and America in the subtribe Lepidolejeuneinae of Lejeuneaceae (He *et al.*, 2012; Bechteler *et al.*, 2016; Zhu

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*et al.*, 2017b). A detailed morphological observation reveals that the plants from Brunei are most similar to *Vitalianthus guangxianus* R.L.Zhu *et al.* from China (He *et al.*, 2012). The plants from Brunei, however, differ from *V. guangxianus* in the larger size of plants (shoots 0.4-0.7 mm wide), obliquely spreading leaves, straight to arched ventral margin of the leaf, leaf lobules 1/3-2/5 as long as the leaf lobes, and usually with the leaf apex incurved (Figs 1-7). Our results of the phylogenetic analyses based on the nuclear ribosomal ITS region and two chloroplast regions (*rbcL*, *trnL-trnF*) (not shown here) substantiate the distinction of these species. Here a new species, *Vitalianthus lamyii*, is described and illustrated.

## MATERIALS AND METHODS

Fresh samples used in this study were collected in Kuala Belalong Field Studies Centre (KBFSC) in Temburong District of Brunei, in December 2015. The field photos were photographed with a digital camera (Sony ILCE-6000). All morphological and anatomical characters were examined using an Olympus BX43 microscope equipped with a DP71 digital camera. The transverse-sections of the stem were obtained using a frozen section method by cryostat microtome (Leica CM1950).

## TAXONOMY

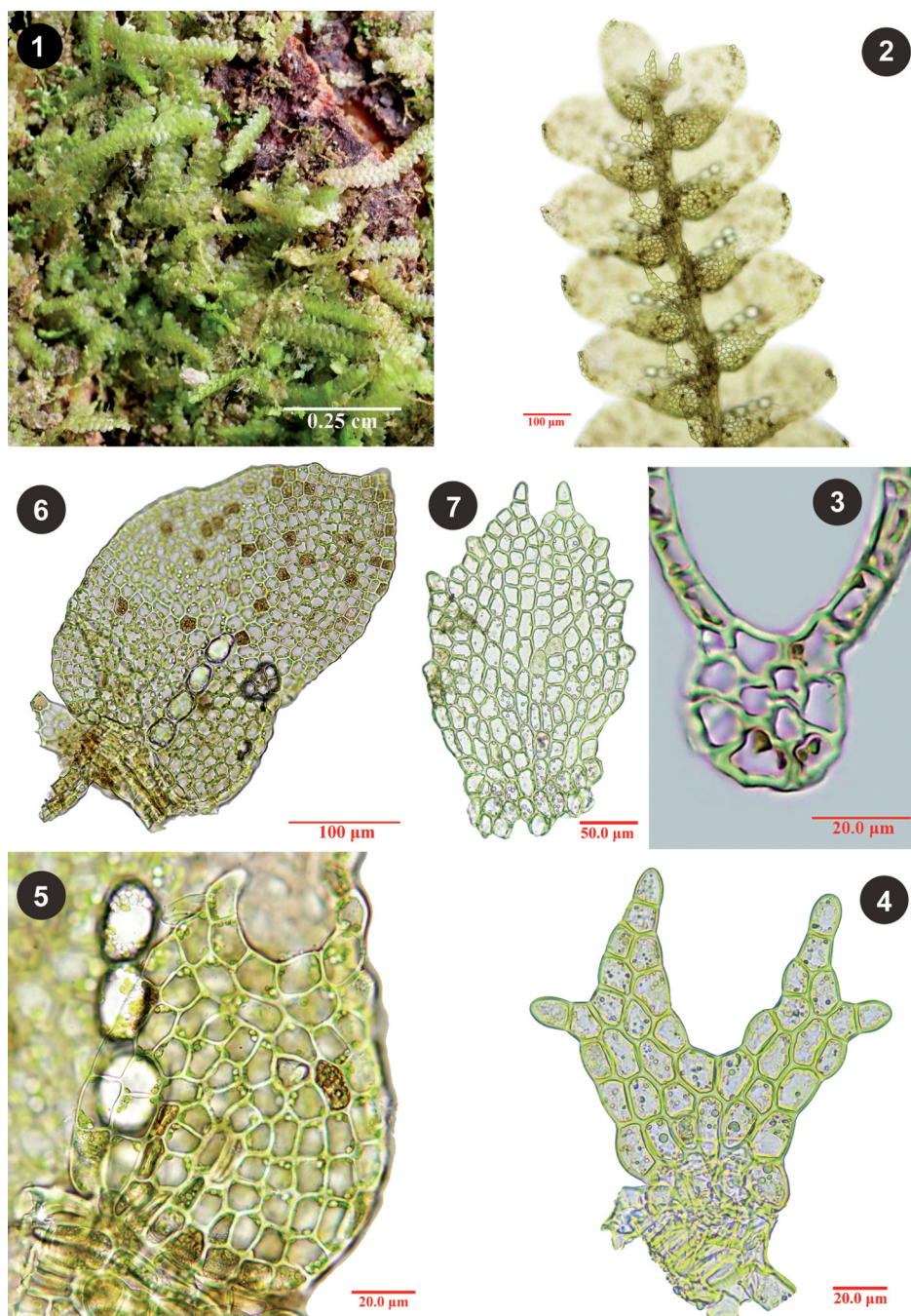
*Vitalianthus lamyii* R.L.Zhu, L.Shu & H.Mohamed, *sp. nov.*

**Figs 1-7**

**Type:** Brunei Darussalam. Temburong, Kuala Belalong, Kuala Belalong Field Studies Centre of the Universiti Brunei Darussalam, 4°33'18.51" N, 115°09'15.53" E, 80 m, on tree trunks, 16 Dec. 2015, R.-L. Zhu *et al.* 20151216-62 (holotype: HSNU!; isotype: UBDH!).

Similar to *Vitalianthus guangxianus* but differing in the larger shoots (0.4-0.7 mm wide), obliquely spreading leaves, straight to arched ventral margin of the leaf, small leaf lobules 1/3-2/5 as long as the leaf lobes, and mostly obtuse to acute, more or less incurved leaf apex.

**Description:** Autoicous. Plants green to yellowish green, 1.5 to 8 mm long. Shoots 0.4-0.7 mm wide, usually scarcely and irregularly branched, branches *Lejeunea*-type, leaf sequence of vegetative branches lejeuneoid. Stems 35-50 µm in diameter, in transverse section with 7 cortical cells and 3 medullary cells, cells rather thick-walled, hyalodermis lacking (Fig. 3); ventral merophyte 2 cells wide. Rhizoids at base of underleaf, few, tufted, usually hyaline, rhizoid disc absent. Leaves imbricate, oblique spreading; leaf lobes asymmetrically oblong-ovate, usually concave, slightly falcate, 0.25-0.30 mm long, 0.17-0.20 mm wide, dorsal margin entire, but usually somewhat remotely dentate near apex, ventral margin entire, straight to weakly arched, apex mostly obtuse to acute, occasionally apiculate, ± incurved; leaf lobules ovate, strongly inflated, 1/3-2/5 as long as the lobes, occasionally reduced; lateral free margin usually slightly incurved (except at apex),



Figs 1-7. *Vitalianthus lamyii* R.L.Zhu, L.Shu & H.Mohamed. 1. Plants creeping on bark of tree trunks. 2. Portion of shoot, ventral view. 3. Transverse section of stem. 4. Underleaf. 5. Leaf lobule showing free lateral margin and hyaline papilla. 6. Leaf showing an unbroken basal vitta of four ocelli, dorsal view. 7. Female bracteole. All from R.-L. Zhu *et al.* 20151216-62 (holotype).

proximal to the notch bordered by 5-6 subquadrate to rectangular marginal cells; apex usually constricted, with a unicellular, somewhat curved apical tooth directed towards leaf apex; hyaline papilla oblong,  $15-17 \times 8-10 \mu\text{m}$ , situated at the proximal base of apical tooth; keel arched, smooth or weakly crenulate. Cells of leaf lobe with moderately thickened walls and very small trigones, without intermediate thickenings, at margin quadrate to rectangular,  $10-15 \times 8-10 \mu\text{m}$ , in the middle  $\pm$  hexagonal,  $12-25 \times 11-17 \mu\text{m}$ , near base similar to median cells in shape, but slightly larger. Oil bodies 2(-3) per median cell of leaf lobe, ovoid or spherical, greyish, compound,  $3.0-5.2 \mu\text{m}$  in diameter. Ocelli oblong,  $30-42 \times 17-23 \mu\text{m}$ , 3-4(-5) per leaf lobe, forming a longitudinal, unbroken row, the lowermost always basal (next to stem cell, the basal type, cf. Zhu & So, 2001). Underleaves remote, longer than wide, 2-3 times as wide as stem, bilobed to  $1/2-2/3$  their length, sinus U-shaped, lobes narrowly triangular, erect, acute at apex, 4-5(-6) cells long (ending in 1-2 superposed cells), (2-)3-4 cells wide at base, inner lateral margin nearly entire, outer lateral one with a distinct tooth (1-2 cells long), insertion line almost straight to subtransverse, base cuneate. Androecia terminal or intercalary, usually on long lateral branches or on main shoots; bracts in 2-5 pairs, bracteoles 1-3, borne only at the basal portion of the androecium, similar to ordinary underleaves. Gynoecia on short or long branches, with 1 pycnolejeuneoid innovation; bracts obovate, 0.40-0.45 mm long, 0.20-0.25 mm wide, deeply and unequally bifid, the lobe broadly ovate, apex obtuse to acute, apical margin usually crenulate, ventral and dorsal margin usually remotely dentate, base with 3-9 ocelli; lobule oblong-triangular,  $2/3-3/4$  as long as the bract



Fig 8. View of the lowland rain forests in Kuala Belalong, Brunei, where the populations of *Vitalianthus lamyii* were found on tree trunks.

lobe, apex acute to acuminate, keel almost straight, *ca.* 1/3 as long as the lobule; bracteole connate with bracts on both sides at base, oblong, 0.25-0.30 mm long, 0.15-0.17 mm wide at middle, outer lateral margin dentate, apex bilobed to *ca.* 1/4 its length, sinus acute and narrow. Perianths 1/4-1/2 exserted, obovoid, 0.35-0.45 mm long, 0.24-0.30 mm wide at middle, inflated, with 4-5 long keels (2 lateral, 2 ventral, 0-1 dorsal), ventral and lateral keels usually crenulate near apex, sometimes with weak denticulations, surface of perianth smooth, beak short, 1-2 cells long, ocelli in perianth present. Sporophytes and asexual reproductive organs not seen.

**Etymology:** The epithet of the species honors Denis Lamy for his contribution to bryology, and especially for his long dedication to *Cryptogamie*, *Bryologie*.

**Habitat and distribution:** *Vitalianthus lamyii* grows on tree trunks, usually associated with *Cheilolejeunea ceylanica* (Gottsche) R.M.Schust. & Kachroo, *Drepanolejeunea vesiculosa* (Mitt.) Steph., *Lepidolejeunea bidentula* (Steph.) R.M.Schust., and *Metalejeunea cucullata* (Reinw. *et al.*) Grolle in the lowland rain forests. This species is known only from the type locality in Brunei Darussalam.

**Additional specimens examined:** Brunei Darussalam. Temburong: Kuala Belalong, Kuala Belalong Field Studies Centre of the Universiti Brunei Darussalam, 4°32'50.02" N, 115°09'34.78" E, 153 m, on tree trunk, 16 Dec. 2015, R.-L. Zhu *et al.* 20151216-47B; *ibid.*, 4°32'54.28" N, 115°09'21.28" E, 141 m, on tree trunk, 17 Dec. 2015, R.-L. Zhu *et al.* 20151217-66A (HSNU); *ibid.*, 4°32'52.43" N, 115°09'34.20" E, 181 m, on tree trunk, 16 Dec. 2015, R.-L. Zhu *et al.* 20151216-52B (HSNU); *ibid.*, 4°32'42.23" N, 115°09'24.18" E, 174 m, on tree trunks, 15 Dec. 2015, R.-L. Zhu *et al.* 20151215-64A (HSNU).

## DISCUSSION

*Vitalianthus* was first established based on the *Drepanolejeunea bischleriana* K.C.Pôrto & Grolle known from Brazil (Schuster & Giancotti, 1993; Wei *et al.*, 2013). Zartman & Ackerman (2002) described the second species of this genus, *Vitalianthus urubuensis* Zartman & I.L.Ackerman from central Amazonia. *Vitalianthus urubuensis*, however, actually is a member of *Cheilolejeunea* (Spruce) Steph. based on morphological and molecular evidence (Wei *et al.*, 2013). The third species, *Vitalianthus guangxianus* R.L.Zhu *et al.*, was found in Guangxi, southwestern China (He *et al.*, 2012). Recently Bechteler *et al.* (2016) transferred the Amazonian *Microlejeunea aphanella* Steph. to *Vitalianthus*. *Vitalianthus* was considered to be most similar to *Drepanolejeunea* (Spruce) Steph. and placed in subtribe Drepanolejeuneinae Gradst. (Gradstein, 2013; Söderström *et al.*, 2016). Most recent molecular phylogenetic studies reveal that this genus is a member of subtribe Lepidolejeuneinae Gradst. (Bechteler *et al.*, 2016; Zhu *et al.*, 2017b). *Vitalianthus* is phylogenetically related to *Capillolejeunea* S.W.Arnell, a 2-species genus known only from the East African Islands (He *et al.*, 2014; Zhu *et al.*, 2017b). *Vitalianthus* is recognized by the minute plants, slender stem consisting of seven cortical cells and three medullary cells in transverse section, unbroken basal vitta of 3-7 ocelli in leaf lobes, usually 2-3 granular oil bodies per leaf cell, proximal hyaline papilla of the leaf lobule, bilobed underleaf with very narrow lobes, gynoeceal innovation with a pycnolejeuneoid leaf sequence, and absence of specialized cladia (Gradstein *et al.*, 2001; He *et al.*, 2012). *Vitalianthus lamyii* is readily separated from other *Vitalianthus* species by the presence of a distinct tooth (1-2 cells long) at the outer lateral margin

of underleaf lobes (Fig. 4). It shows a striking variation, especially in leaf apex. The leaf apex is mostly obtuse to acute, but tends to be somewhat apiculate in well-developed plants, as in *V. bischlerianus*. *Vitalianthus lamyii* also resembles *V. bischlerianus* in the shape and size of leaves, small leaf lobules 1/3-2/5 as long as leaf lobes, and shortly obovate perianths with 4-5 keels. The latter, however, differs in the entire outer lateral margins of female bracteoles, entire or weakly angular outer lateral margins of underleaf lobes, and tendencies toward lobule reduction. Although *V. lamyii* is morphologically similar to *V. bischlerianus*, phylogenetically it is more related to *V. guangxianus* (unpublished data), which has ovate, erect to suberect leaves (He *et al.*, 2012). Their differences are shown in the following key.

With the description of the new species from Borneo, four species are now included in *Vitalianthus*, including two from the Neotropics and two from tropical Asia. The discovery of *V. lamyii* in Borneo expands the geographical range of the genus to Sundaland. More detailed investigation of liverworts in pristine lowland forests in tropical Asia may lead to the discovery of further localities of this species. The known species of *Vitalianthus* are distinguished in the following key.

1. Female bracteoles dentate at outer lateral margin; underleaf lobe (2-)3-4 cells wide at base; outer lateral margins of underleaf lobes  $\pm$  toothed; known from tropical Asia .....2
1. Female bracteoles entire at outer lateral margin; underleaf lobe mostly 2(-3) cells wide at base; outer lateral margins of underleaf lobes entire or weakly angular; known from tropical America .....3
- Shoots 0.4-0.7 mm wide; leaves oblong-ovate, obliquely spreading; leaf lobules 1/3-2/5 as long as the lobes; outer lateral margin of underleaf lobes with a distinct tooth (1-2 cells long); known from Borneo ..... *V. lamyii*
- Shoots 0.2-0.3(-0.4) mm wide; leaves ovate, almost erect; leaf lobules usually 1/2-3/4 as long as the lobes; outer lateral margin of underleaf lobes entire to angular; known from China ..... *V. guangxianus*
3. Ventral margin of leaf usually weakly curved; leaves mostly oblong-ovate, obliquely to widely spreading, imbricate; known from Brazil.... *V. bischlerianus*
3. Ventral margin of leaf usually arched; leaves oblong, erect to suberect, usually remote; known from Brazil, French Guiana and Colombia (Campos *et al.*, 2014 as *Microlejeunea aphanella*) ..... *V. aphanellus*

**Acknowledgments.** We thank Chao-Xian Zhao, Chatchaba Promma, and the staff of the Kuala Belalong Field Studies Centre of the Universiti Brunei Darussalam for field assistance, Chun-Hong Lu, Jing Yin and Xia-Fang Cheng for the preparation of partial illustrations. This research was supported by the National Natural Science Foundation of China (nos. 31370238, 31570206 and 31770224).

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