Bamboo diversity in Weh Island, Aceh, Indonesia

MUHAMMAD AZLI RITONGA1,*, SYAMSUARDI2, NURAINAS3, I PUTU GEDE P. DAMAYANTO3

1Biology Graduate Program, Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Andalas. Jl. Unand, Kampus Limau Manis, Padang 25163, West Sumatra, Indonesia. Tel.: +62-751-777427,*email: muhammadazli405@gmail.com
2Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Andalas. Jl. Unand, Kampus Limau Manis, Padang 25163, West Sumatra, Indonesia
3Herbarium Bogoriense, Research Center for Biosystematics and Evolution, National Research and Innovation Agency. Jl. Raya Jakarta-Bogor Km 46, Cibinong, Bogor 16911, West Java, Indonesia


Abstract. Ritonga MA, Syamsuardi, Nurainas, Damayanto IPGP. 2023. Bamboo diversity in Weh Island, Aceh, Indonesia. Biodiversitas 24: 2563-2576. Bamboo is an important plant resource in Indonesia, whose inventories were mostly conducted on the main islands. In contrast, the inventory for small islands, such as Weh Island in Northern Sumatra, has never been done. Weh Island, however, is an atoll island that has been raised above sea level and is suspected to have a unique diversity of flora, especially bamboo. This study aimed to understand the diversity of bamboo on Weh Island. Fieldwork was conducted in August-September 2022 in Weh Island, Aceh, Indonesia. Bamboo specimens were collected by collecting flora diversity method and deposited in Herbarium Andalas and Herbarium Bogoriense. Morphological characteristics were observed to identify and arrange species descriptions and as a determination key. The spatial distribution of bamboo was analyzed using QGIS software and overlaid with a land cover and altitude map. We also performed a similarities analysis using morphological characteristic. There are eight species of bamboo on Weh Island: Bambusa multiplex (Lour.) Raesusch. ex Schult.f., Bambusa spinosa Roxb., Bambusa tuloides Munro, Bambusa vulgaris Schrad. ex J.C.Wendl., Dendrocalamus asper (Schult.f.) Backer, Schizostachyum brachycladum (Kurz ex Munro) Kurz, Schizostachyum silicatum Widjaja, and Thysostachys siamensis Gamble. B. vulgaris is most abundant and widespread on Weh Island; meanwhile, B. multiplex and B. tuloides are the least common. The presence of S. silicatum on Weh Island and Bangka Island was additional information on the expansion of these species distributions outside the mainland of Sumatra. Bamboos on Weh Island were found around settlements, plantations, and forests at 1 to 212 m asl. Bamboo species on Weh Island can be clustered into four groups based on their morphological characteristics.

Keywords: Bambusoideae, diversity, Poaceae, Sabang, spatial distribution

INTRODUCTION

Woody bamboo belongs to the Poaceae family and is the sub-family of Bambusoideae (Zhou et al. 2017). Generally, bamboo has cylindrical, hollow, and segmented culms and is covered with sheaths (Widjaja 2001). Bamboo nodes bear leafy branches. Bamboo reproduces mainly by rhizomes so that it grows in a clump, especially in the tropics. Bamboos in the sub-tropic are generally running bamboo due to their long necks of rhizomes. The bamboo inflorescences are spikelets, and some species rarely flower (Janzen 1976). The bamboo fruit is indehiscent and the single-seed or some species with fleshy and spherical to pear-shaped.

Bamboo is a cultivated plant and one of the community plantations grown in rural areas. Besides being cultivated, bamboo can also be found growing wild in primary and secondary forests (Damayanto and Fefirenta 2021). In Indonesia, bamboo is known to have high interaction with the communities. Most bamboo species in Indonesia have been used by people in daily life, i.e. as materials for making houses, households utensil, furniture, crafts (Tamang et al. 2013; Honfo et al. 2015; Liana et al. 2017; Ervany et al. 2020; Ritonga et al. 2020; Hanun et al. 2023), fish trap (Damayanto et al. 2016), food container (Damayanto and Rahmawati 2020), firewood (Damayanto et al. 2018), medicines, and vegetables (Damayanto 2018, Sholekha et al. 2023). Ecologically, bamboo can resist erosion. Furthermore, bamboo roots can maintain the hydrological system because they bind water (Yasin and Priyanto 2019; Kaushal et al. 2020; Dlamini et al. 2022). In addition, bamboo acts as carbon storage (Deví and Singh 2021). Thus, it can lighten the greenhouse effect. Bamboo is also known as the habitat of animals such as civet Paradoxurus hermaphroditus Pallas 1777 (musang luwak) that reportedly made a nest in a bamboo clump in Sumba, Indonesia (Hamidy et al. 2017). In addition, the ghost orchid, Didymoplexis pallens Griff., was known to grow under bamboo clumps (Zulkarnaen et al. 2020).

There are an estimated 1,439 to 1,662 species of bamboo in the world (Widjaja et al. 2014; Canavan et al. 2017). In Indonesia alone, it is estimated 176 species of bamboo (Widjaja 2019), although Damayanto and Fefirenta (2021) corrected that there are 175 species of bamboo in Indonesia according to Widjaja (2019). There are 105 species of bamboo in Indonesia that are endemic to the...
region (Widjaja 2019). Bamboo inventories in Indonesia, however, were mostly conducted on the main islands (Damayanto et al. 2015, 2020b; Hidayatullah 2016; Erviati et al. 2019a, 2019b; Muzakki 2020; Muzakki et al. 2020). Bamboo inventory on small islands in Indonesia is less of a concern, even though it can potentially discover something new. For example, Widjaja (2020) has described a new bamboo species from Alor Island, East Nusa Tenggara. Damayanto (2018) reports new records of bamboo distribution in Indonesia found on Karimun and Batam Islands, Sumatra. Therefore, it is necessary to study the diversity of bamboo in small islands in Indonesia to reveal the richness of bamboo and its potency.

A bamboo inventory for small islands in Indonesia, especially Weh Island, has never been done. Administratively, Weh Island (also known as Sabang Island) belongs to Sabang, Aceh Province, Indonesia, with an area of 120.7 km² (PKS 2023). Geographically, Weh Island is located at the westernmost tip of Sumatra Island at 05°46’28”–05°54’28” N and 95°13’02”–95°22’36” E (BPSKS 2020). This island is formed due to volcanic movement; it is divided into three terraces with the highest plateau in the western part of the island, namely Mt. Jaboi, with an altitude of 617 m above sea level (asl) (Kurniyo et al. 2015). Weh Island is an atoll island that has been raised above sea level and is suspected to having a unique diversity of flora, especially bamboo. This study aimed to understand the diversity of bamboo on Weh Island. In addition, this study can be used as basic data for bamboo conservation efforts on this island.

MATERIALS AND METHODS

Study period and area

Fieldwork occurred on Weh Island, Aceh Province, Indonesia, from August to September 2022. Several villages on Weh Island were surveyed based on local communities’ information (Table 1 and Figure 1).

Table 1. The locations of the fieldwork on Weh Island, Aceh Province, Indonesia

<table>
<thead>
<tr>
<th>Code</th>
<th>District/City</th>
<th>Subdistrict</th>
<th>Villages</th>
<th>Coordinate</th>
<th>Altitude (m asl.)</th>
<th>Major surrounding landscape</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Sabang City</td>
<td>Sukajaya</td>
<td>Anoe Itam</td>
<td>5°49’39.07” N, 95°22’21.55” E</td>
<td>6-62</td>
<td>Forests and plantations</td>
</tr>
<tr>
<td>B</td>
<td>Sabang City</td>
<td>Sukajaya</td>
<td>Balohan</td>
<td>5°50’10.30” N, 95°20’26.71” E</td>
<td>2-131</td>
<td>Settlements and forests</td>
</tr>
<tr>
<td>C</td>
<td>Sabang City</td>
<td>Sukajaya</td>
<td>Cot Abeuk</td>
<td>5°51’05.35” N, 95°20’31.29” E</td>
<td>17-164</td>
<td>Settlements</td>
</tr>
<tr>
<td>D</td>
<td>Sabang City</td>
<td>Sukajaya</td>
<td>Cot Ba’u</td>
<td>5°52’03.24” N, 95°20’12.62” E</td>
<td>13-153</td>
<td>Settlements and a lake</td>
</tr>
<tr>
<td>E</td>
<td>Sabang City</td>
<td>Sukajaya</td>
<td>Jaboi</td>
<td>5°47’43.23” N, 95°20’31.21” E</td>
<td>2-12</td>
<td>Settlements and forests</td>
</tr>
<tr>
<td>F</td>
<td>Sabang City</td>
<td>Sukajaya</td>
<td>Ujong Kareung</td>
<td>5°53’02.59” N, 95°20’54.82” E</td>
<td>0-12</td>
<td>Settlements</td>
</tr>
<tr>
<td>G</td>
<td>Sabang City</td>
<td>Sukakarya</td>
<td>Aneuk Laot</td>
<td>5°51’59.95” N, 95°19’55.64” E</td>
<td>12-51</td>
<td>Settlements and plantations</td>
</tr>
<tr>
<td>H</td>
<td>Sabang City</td>
<td>Sukakarya</td>
<td>Batee Shoek</td>
<td>5°49’06.28” N, 95°18’27.24” E</td>
<td>12-165</td>
<td>Forests and rivers</td>
</tr>
<tr>
<td>I</td>
<td>Sabang City</td>
<td>Sukakarya</td>
<td>Iboih</td>
<td>5°52’34.66” N, 95°15’53.72” E</td>
<td>0-1</td>
<td>Settlements</td>
</tr>
<tr>
<td>J</td>
<td>Sabang City</td>
<td>Sukakarya</td>
<td>Kuta Ateuh</td>
<td>5°53’42.60” N, 95°19’21.41” E</td>
<td>6-32</td>
<td>Settlements</td>
</tr>
<tr>
<td>K</td>
<td>Sabang City</td>
<td>Sukakarya</td>
<td>Kuta Timu</td>
<td>5°53’26.39” N, 95°19’26.94” E</td>
<td>35-36</td>
<td>Settlements</td>
</tr>
<tr>
<td>L</td>
<td>Sabang City</td>
<td>Sukakarya</td>
<td>Paya</td>
<td>5°48’33.40” N, 95°17’54.20” E</td>
<td>26-213</td>
<td>Settlements and rivers</td>
</tr>
<tr>
<td>M</td>
<td>Sabang City</td>
<td>Sukakarya</td>
<td>Paya Seunara</td>
<td>5°51’07.98” N, 95°19’05.87” E</td>
<td>32-100</td>
<td>Rivers</td>
</tr>
</tbody>
</table>

Figure 1. The locations of the fieldwork in Weh Island, Aceh Province, Indonesia. Note: Village names (A-M) refer to Table 1.
Procedures

Bamboo exploration was carried out using a method of collecting flora diversity (Rugayah et al. 2004) by exploring the study site through forest trails, along riverbanks, the edge of the forest, along the roads, and the villages. During exploration, samples of bamboo were collected using the method of Djarwaningsih et al. (2002), which involved gathering parts of the young shoots (approximately 20-30 cm in length), branches, leafy branches, culm sheaths, and inflorescences (if available). A hanging label was attached to each sample, indicating the collector’s name, collection number, and collection date. Additional information such as habitat, location, coordinates, altitude, and local name were recorded, and photographic documentation was also taken. The bamboo samples were then meticulously pressed and dried in an oven before being identified using the specimen collections at ANDA and BO for further processing (Djarwaningsih et al. 2002) to create herbarium specimens. Herbarium bogoriense (BO) and Herbarium Bogoriense (ANDA) were identified as the accepted names of the species followed Vorontsova et al. (2016), Widjaja and Wong (2016), Wong and Dransfield (2016), and websites the International Plant Names Index (https://ipni.org) or the Plants of the World Online (https://powo.science.kew.org) see Damayanto et al. 2020, we performed a similarity analysis using the Multi-Variate Statistics Package (MVSP) with the unweighted pair group method with arithmetic mean (UPGMA) and the coefficient of Nei & Li. The dendrogram resulting from the similarity analysis was then analyzed descriptively to identify clusters and patterns within the data.

Table 2. Morphological characteristics for a similarity analysis

<table>
<thead>
<tr>
<th>Morphological characters</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culm color</td>
<td>Green (0); yellow (1); green/yellow (2); others (3)</td>
</tr>
<tr>
<td>Culm stripes</td>
<td>Absent (0); present (1); others (2)</td>
</tr>
<tr>
<td>Culm diameter</td>
<td>&lt;7 cm (0); ≥7 cm (1)</td>
</tr>
<tr>
<td>Culm height</td>
<td>&lt;10 m (0); ≥10 m (1)</td>
</tr>
<tr>
<td>Culm internodes</td>
<td>&lt;40 cm (0); ≥40 cm (1)</td>
</tr>
<tr>
<td>Culm-sheath persistency</td>
<td>Caducous (0); persistent (1)</td>
</tr>
<tr>
<td>Culm-sheath length</td>
<td>&lt;30 cm (0); ≥30 cm (1)</td>
</tr>
<tr>
<td>Culm-sheath width</td>
<td>&lt;30 cm (0); ≥30 cm (1)</td>
</tr>
<tr>
<td>Shape of culm-sheath auricles</td>
<td>Rim-like or inconspicuous (0); small (1); rounded (2)</td>
</tr>
<tr>
<td>Bristle of culm-sheath auricles</td>
<td>Present (0); absent (1)</td>
</tr>
<tr>
<td>Bristle length of culm-sheath auricles</td>
<td>Absent (0); &lt;3 mm (1); ≥3 mm (2)</td>
</tr>
<tr>
<td>Height of culm-sheath ligule</td>
<td>&lt;0.5 cm (0); ≥0.5 cm (1)</td>
</tr>
<tr>
<td>Culm-sheath ligule</td>
<td>Entire (0); toothed (1)</td>
</tr>
<tr>
<td>Bristle of culm-sheath ligule</td>
<td>Present (0); absent (1)</td>
</tr>
<tr>
<td>Bristle length of culm-sheath ligule</td>
<td>Absent (0); ≤1 cm (1); ≥1 cm (2)</td>
</tr>
<tr>
<td>Position of mature culm-sheath blade</td>
<td>Deflexed (0); erect (1); spreading (2); erect to deflexed (3); spreading to deflexed (4)</td>
</tr>
<tr>
<td>Shape of culm-sheath blade</td>
<td>Oblong (0); broadly lanceolate (1); narrowly lanceolate (2); broadly triangular (3); narrowly triangular (4); linear (5)</td>
</tr>
<tr>
<td>Length of culm-sheath blade</td>
<td>&lt;15 cm (0); ≥15 cm (1)</td>
</tr>
<tr>
<td>Width of culm-sheath blade</td>
<td>&lt;5 cm (0); ≥5 cm (1)</td>
</tr>
<tr>
<td>Branches</td>
<td>One dominant branch and several smaller branches (0); several sub-equal branches (1)</td>
</tr>
<tr>
<td>Branch spines</td>
<td>Absent (0); present (1)</td>
</tr>
<tr>
<td>Length of lamina leaves</td>
<td>&lt;30 cm (0); ≥30 cm (1)</td>
</tr>
<tr>
<td>Width of lamina leaves</td>
<td>&lt;4 cm (0); ≥4 cm (1)</td>
</tr>
<tr>
<td>Shape of leaf-sheath auricles</td>
<td>Rim-like or inconspicuous (0); small (1); rounded (2)</td>
</tr>
<tr>
<td>Bristles of leaf-sheath auricles</td>
<td>Absent (0); present (1)</td>
</tr>
<tr>
<td>Bristle length of leaf-sheath auricles</td>
<td>Absent (0); ≤1 cm (1); ≥1 cm (2)</td>
</tr>
<tr>
<td>Height of leaf-sheath ligule</td>
<td>&lt;2 mm (0); ≥2 mm (1)</td>
</tr>
<tr>
<td>Bristles of leaf-sheath auricles</td>
<td>Absent (0); present (1)</td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSION

There are eight species and four genera of bamboo on Weh Island, namely Bambusa multiplex (Lour.) Raeusch. ex Schult.f., Bambusa spinosa Roxb., Bambusa tulidoides Munro, Bambusa vulgaris Schrad. ex J.C.Wendl., Dendrocalamus asper (Schult.f.) Backer, Schizostachyum brachycladum (Kurz ex Munro) Kurz, Schizostachyum silicatum Widjaja, and Thrysostachys siamensis Gamble.

Determination key to the genera of bamboo in Weh Island
1 a. Branch complements with several sub-equal branches.......................... Schizostachyum
   b. Branch complements with one dominant branch and several smaller branches..........................2
2 a. Culms slightly zigzag, internodes relatively short in the middle part of culm.........................Bambusa
   b. Culms relatively straight, internodes relatively long in the middle part of culm.......................3
3 a. Clumps closely to densely tufted; culms moderately thick to thick and rarely solid in lower part; leaves lanceolate to oblong......................Dendrocalamus
   b. Clumps very densely tufted; culms very thick and solid in lower part; leaves narrow and linear ..................................................Thrysostachys

Determination key to the bamboo species in Weh Island
1 a. Branch complements with several sub-equal branches..................................................2
   b. Branch complements with one dominant branch and several smaller branches..........................3
2 a. Culm-sheath blades erect, broadly triangular; culm-sheath auricles rounded ..................S. brachycladum
   b. Culm-sheath blades deflexed, narrowly lanceolate or linear; culm-sheath auricles inconspicuous.................................................................3
3 a. Clumps very densely tufted; culms-sheathed covered with white hairs; culms very thick and solid in lower part; culms-greyish-green and usually covered with persistent old culm-sheaths......................T. siamensis
   b. Clumps closely to densely tufted; culm-sheath blades usually covered with brown to black hairs and rarely white; culms moderately thick to thick and rarely solid in lower part; culms green, green with yellow striped, yellow with green striped and rarely covered with persistent old culm-sheaths......................4
4 a. Culms relatively straight; young culms covered with velvety golden-brown appressed hairs, later glabrous; internodes relatively long in the middle part of culm; nodes with aerial roots in the lower to the upper part of culm ..........................................................D. asper
   b. Culms slightly zigzag; young culms covered with brown to black hairs, later persistent or glabrous; internodes relatively short in the middle part of culm; nodes with aerial roots only in the lower part of culm .................................................................................5
5 a. Culms and branches bearing spines..............B. spinosa
   b. Culms and branches without spines......................6
6 a. Culm-sheath auricles rim-like; leaf-blades whitish-green................................................B. multiplex
   b. Culm-sheath auricles rounded; leaf-blades green........................7
7 a. Culm-sheaths glabrous, apex asymmetrically arched .........................................................B. tulidoides
   b. Culm-sheaths hairy, apex symmetrical arched.............B. vulgaris

List of bamboo species in Weh Island


Morphological description. Symподial bamboo and densely tufted. Young shoots green, covered with white wax. Culms green to yellowish-green, slightly zigzag, 3-5 m high, 0.5-2 cm in diameter, internodes 16-22 cm, erect with arching tips. The branch complements with one dominant branch and several smaller branches. Culm-sheaths deciduous and glabrous, 10.5-14.5×3-4 cm; auricles rim-like, 1-2 mm high, bristles 2 mm long; ligule irregularly toothed, up to 1 mm high, glabrous; blades erect, triangular, 4-9×1.4 cm. Leaf-blades whitish-green, 7.5-12×1-1.4 cm; leaf-sheath auricles small, up to 1 mm high, bristles short up to 1 mm long; ligule toothed up to 1 mm high, glabrous. The inflorescence is unavailable. Based on Dransfield and Widjaja (1995a), inflorescence with linear-lanceolate spikelet, spikelet 3-4 cm long, glumes 2, fertile florets up to 10 with a rudimentary in uppermost.

Habitat and ecology. Settlements on the edge of the market at 14 m asl.

Distribution. Kuta Ateueh Village, Sukakarya Subdistrict (Figure 3A).

Local name(s). Ikeuha pageu or ikeuha kawe (Aceh).

Specimen(s) examined. Sumatra, Aceh, Weh Island, Sukakarya Subdistrict, Kuta Ateueh Village, 5°53′51.68″ N 95°19′5.44″ E, 31 August 2022, M. A. Ritonga 073 (ANDA, BO).

Bambusa spinosa Roxb.

Bambusa spinosa Roxb., Hort. Bengal.: 25. 1814. Figure 2B. Type: Herb. Amboin, Rumphius. 4: t. 3. 1743 (Lectotype designated by Merrill in 1917 “An Interpretation of Rumphius’s Herbarium Amboinense”).

**Bambusa pudica** (L.) Roxb. 
**Bambusa burutton** (L.) Schrad. 
**Bambusa vulgaris** Schrad. ex J.C. Wendl.

**Distribution.** Kuta Ateuh Village, Sukakarya Subdistrict (Figure 3C).

**Local name(s).** Trieng biason (Aceh).

**Specimen(s) examined.** Sumatra, Aceh, Weh Island, Sukakarya Subdistrict, Kuta Ateuh Village, 5°53'51.76" N 95°1'6.89" E, 31 August 2022, M. A. Ritonga 075 (ANDA, BO).

**Bambusa vulgaris** Schrad. ex J.C. Wendl.

**Distribution.** Villages of Balohan and Jaboi, Sukakarya Subdistrict (Figure 3B).

**Local name(s).** Trieng daroe (Aceh).

**Specimen(s) examined.** Sumatra, Aceh, Weh Island, Sukakarya Subdistrict, Balohan Village, 5°49'58.60" N 95°20'37.90" E, 30 August 2022, M. A. Ritonga 038 (ANDA, BO); Jaboi Village, 5°47'42.93" N 95°20'35.94" E, 30 August 2022, M. A. Ritonga 042 (ANDA, BO); Balohan Village, 5°49'49.15" N 95°20'45.64" E, 30 August 2022, M. A. Ritonga 054 (ANDA, BO).

**Bambusa tuldoides** Munro

**Bambusa tuldoides** Munro, Trans. Linn. Soc. London 26: 93. 1868. Figure 2C. Type: Hongkong, Hance 3657 (syntype BM!).


**Morphological description.** Sympodial bamboo and densely tufted. Young shoots green, glabrous, or covered with brown hairs. Culms green, slightly zigzag, 3-6 m high, 1.5-5 cm in diameter, internodes 28-31 cm, erect, and internodes inflated in dry areas or cultivated in a pot. The branch complements with one dominant branch and several smaller branches. Culms-sheaths deciduous and glabrous, 12.5-15x4.5-8 cm, apex asymmetrically arched; auricles rounded, small, 3-4 mm high, bristles up to 3 mm long; ligule entire, up to 1 mm high; glabrous; blades erect, triangular, 3.5-5x1.5-2 cm. Leaf-blades green, 12-18.5x1-3 cm; leaf-sheath auricles small, up to 1 mm high, bristles short up to 2 mm long; ligule entire up to 1 mm high, glabrous. The inflorescence is unavailable. Based on But and Chia (1995), inflorescence with 2-5 cm long spikelet, bearing 2-5 perfect florets and above these 1-2 reduced florets.

**Habitat and ecology.** Along the main road near the market and near the settlements at 14 m asl.
(ANDA, BO); Anoe Itam Village, 5°50’1.05” N 95°22’22.04” E, 1 September 2022, M. A. Ritonga 082 (ANDA, BO); Sukakarya Subdistrict, Batee Shoek Village, 5°48’53.63” N 95°18’28.34” E, 31 August 2022, M. A. Ritonga 055 (ANDA, BO); Paya Village, 5°48’37.14” N 95°18’28.39” E, 31 August 2022, M. A. Ritonga 056 (ANDA, BO); Paya Village, 5°48’33.40” N 95°17’54.20” E, 31 August 2022, M. A. Ritonga 057 (ANDA, BO); Paya Seunara Village, 5°51’7.98” N 95°19’5.87” E, 31 August 2022, M. A. Ritonga 058 (ANDA, BO); Aneuk Laot Village, 5°52’27.64” N 95°19’22.23” E, 31 August 2022, M. A. Ritonga 059 (ANDA, BO); Aneuk Laot Village, 5°52’24.89” N 95°19’21.75” E, 31 August 2022, M. A. Ritonga 060 (ANDA, BO); Aneuk Laot Village, 5°51’59.95” N 95°19’55.64” E, 31 August 2022, M. A. Ritonga 059 (ANDA, BO); Kuta Ateueh Village, 5°53’51.62” N 95°19’5.68” E, 31 August 2022, M. A. Ritonga 074 (ANDA, BO);

Dendrocalamus asper Backer ex Heyne


Figure 2. A. B. multiplex; B. B. spinosa; C. B. tuldoides; D. B. vulgaris var. vulgaris; and E. B. vulgaris var. striata. Photos: Muhammad Azli Ritonga
**Morphological description.** Sympodial bamboo and densely tufted. Young shoots purplish-black, covered with blackish-brown hairs. Young culms covered with velvety golden-brown appressed hairs, later glabrous. Culms green, relatively straight, 10-22 m high, 10-15 cm in diameter, internodes 23.5-30 cm, erect, nodes with aerial roots in the lower to the upper part of culm. The branch complements with one dominant branch and several smaller branches. Culm-sheaths deciduous and covered with brown to black hairs, 37-46×16-20 cm; auricles rounded and crisp-edged, 3-4 mm high, bristles 1-2 mm long; ligule entire up to 1 mm high, bristles short; blades deflexed, narrowly triangular, up to 12×2 cm. Leaf-blades green, 32-47×3.5-8 cm; leaf-sheath auricles small, up to 1 mm high, glabrous; ligule entire up to 1 mm high, bristles 1-2 mm long.

**Habitat and ecology.** Along the main road, riverbanks, and settlements at 36-51 m asl.

**Distribution.** Villages of Batee Shoek and Aneuk Laot, Sukakarya Subdistrict (Figure 5A).

**Local name(s).** Trieng betung (Aceh).

**Specimen(s) examined.** Sumatra, Aceh, Weh Island. Sukakarya Subdistrict, Batee Shoek Village, 5°50’12.73” N 95°17’59.57” E, 31 August 2022, M. A. Ritonga 060 (ANDA, BO); Aneuk Laot Village, 5°52’24.08” N 95°19’26.08” E, 1 September 2022, M. A. Ritonga 081 (ANDA, BO).

**Schizostachyum brachycladum (Kurz ex Munro) Kurz**


**Homotypic synonym(s).** Melocanna zollingeri var. brachyclada Kurz ex Munro, Trans. Linn. Soc. London 26: 134. 1868.

**Morphological description.** Sympodial bamboo and densely tufted. Young shoots yellowish-green, covered with dark brown hairs. Culms green or yellow with green stripes, relatively straight, 4-14 m high, 1.5-5.5 cm in diameter, internodes 37-68 cm, erect. The branch complements with several sub-equal branches. Culm-sheaths long persistent and covered with brown hairs, 27×18 cm; auricles small, 2-3 mm high, bristles up to 5 mm long; ligule entire, up to 1 mm high, glabrous; blades erect, broadly triangular, 9-11×4.5-8 cm. Leaf-blades green or sometimes with white stripes along the midrib, 23-31.5×2.5-6 cm; leaf-sheath auricles small, up to 1 mm high, bristles 3-11 mm long; ligule entire up to 1 mm high, glabrous. Inflorescence 16-27 cm long, spikelet 1-1.5 cm long, comprising 1-2 perfect florets and a rachilla extension bearing a rudimentary floret.

**Habitat and ecology.** Riverbanks, backyard, along the main road, and settlements at 24-45 m asl.
Distribution. Balohan Village, Sukakarya Subdistrict and Villages of Kuta Timu and Batee Shoek, Sukakarya Subdistrict (Figure 5B).

Local name(s). Baloh leumang (Aceh).

Notes. This species has two varieties: culm with green color and yellow with green stripes. In Weh Island, only the green culm was found.

Specimen(s) examined. Sumatra, Aceh, Weh Island, Sukajaya Subdistrict, Balohan Village, 5°50'10.30" N 95°20'26.71" E, 30 August 2022, M. A. Ritonga 040 (ANDA, BO). Sukakarya Subdistrict, Batee Shoek Village, 5°50'12.41" N 95°17'30.23" E, 31 August 2022, M. A. Ritonga 063 (ANDA, BO); Kuta Timu Village, 5°53'26.39" N 95°19'26.94" E, 31 August 2022, M. A. Ritonga 071 (ANDA, BO).

Schizostachyum silicatum Widjaja

Schizostachyum silicatum Widjaja, Reinwardtia 11(2): 145. 1997. Figure 4C. Type: Indonesia, Sumatra, Priaman, Kurn s.n. (holotype BO!).

Morphological description. Sympodial bamboo and very densely tufted. Young shoots green, covered with pale brown hairs. Culms green, relatively straight, 2-10 m high, 0.6-2.5 cm in diameter, internodes 31-87 cm, erect. The branch complements with several sub-equal branches. Culm-sheaths long persistent and covered with pale brown hairs, 19-28.5x3-6 cm; auricles inconspicuous, 2-4 mm high, bristles up to 4 mm long; ligule entire, up to 1 mm high, glabrous; blades deflexed, narrowly triangular or linear, 12.5-15x0.5-5.4 cm. Leaf-blades green 12.5-31.5x4.5-6.5 cm; leaf-sheath auricles small, up to 1 mm high, bristles 10-14 mm long; ligule entire up to 1 mm high, glabrous. Inflorescence 15-28 cm long, spikelet 1-2 cm long, fertile floret 1.

Habitat and ecology. Forest and along the main road at 8-131 m asl.

Distribution. Villages of Balohan and Anoe Itam, Sukajaya Subdistrict and Batee Shoek Village, Sukakarya Subdistrict (Figure 5C).

Local name(s). Igueh (Aceh).

Specimen(s) examined. Sumatra, Aceh, Weh Island, Sukajaya Subdistrict, Balohan Village, 5°49'50.36" N 95°21'27.80" E, 30 August 2022, M. A. Ritonga 037 (ANDA, BO); Balohan Village, 5°50'28.28" N 95°20'50.58" E, 30 August 2022, M. A. Ritonga 047 (ANDA, BO); Balohan Village, 5°49'31.24" N 95°21'22.60" E, 30 August 2022, M. A. Ritonga 053 (ANDA, BO); Anoe Itam Village, 5°49'41.45" N 95°22'16.82" E, 1 September 2022, M. A. Ritonga 077 (ANDA, BO); Anoe Itam Village, 5°49'41.08" N 95°22'18.93" E, 1 September 2022, M. A. Ritonga 078 (ANDA, BO); Anoe Itam Village, 5°49'30.04" N 95°22'24.93" E, 1 September 2022, M. A. Ritonga 080 (ANDA, BO); Anoe Itam Village, 5°49'50.7" N 95°22'29.99" E, 1 September 2022, M. A. Ritonga 083 (ANDA, BO). Sukakarya Subdistrict, Batee Shoek Village, 5°50'12.41" N 95°17'30.23" E, 31 August 2022, M. A. Ritonga 062 (ANDA, BO); Batee Shoek Village, 5°49'6.28" N 95°18'27.24" E, 31 August 2022, M. A. Ritonga 065 (ANDA, BO).

Thrysostachys siamensis Gamble


Morphological description. Sympodial bamboo and very densely tufted. Young shoots pale green to purplish-green, glabrous. Culms green, relatively straight, 8-11 m high, 3.5-8 cm in diameter, internodes 15-36 cm, erect. The branch complements with one dominant branch and several smaller branches. Culm-sheaths persistent and covered with white hairs, 24.5-27.5x5.5-9.5 cm; auricles inconspicuous, glabrous; ligule entire, up to 1 mm high, glabrous; blades erect, triangular, persistent. Leaf-blades green or whitish-green, 6-17x0.6-1 cm; leaf-sheath auricles inconspicuous, glabrous; ligule entire up to 1 mm high, glabrous. The inflorescence is unavailable. Based on Duryiaprapan and Jansen (1995), inflorescence with 17 mm long spikelet, usually 2 perfect florets and a rachilla extension bearing a rudimentary floret.

Habitat and ecology. Along the main road, riverbanks, forests, plantations, and near settlements at 12-212 m asl.

Distribution. Villages of Balohan, Jaboi, Cot Abeuk, Cot Ba’u, and Ujong Kareung in Sukajaya Subdistrict and Villages of Batee Shoek, Paya, Iboih, and Kuta Ateueh in Sukakarya Subdistrict (Figure 5D).

Local name(s). Trieng pageue (Aceh).

Specimen(s) examined. Sumatra, Aceh, Weh Island, Sukajaya Subdistrict, Balohan, 5°50'10.16" N 95°20'27.27" E, 30 August 2022, M. A. Ritonga 041 (ANDA, BO); Jaboi Village, 5°47'43.23" N 95°20'31.21" E, 30 August 2022, M. A. Ritonga 043 (ANDA, BO); Jaboi Village, 5°47'34.22" N 95°20'31.20" E, 30 August 2022, M. A. Ritonga 044 (ANDA, BO); Balohan Village, 5°49'59.63" N 95°20'39.47" E, 30 August 2022, M. A. Ritonga 046 (ANDA, BO); Cot Abeuk Village, 5°51'5.35" N 95°20'31.29" E, 30 August 2022, M. A. Ritonga 048 (ANDA, BO); Cot Abeuk Village, 5°51'27.97" N 95°20'59.44"E, 30 August 2022, M. A. Ritonga 049 (ANDA, BO); Cot Ba’u Village, 5°52'3.24" N 95°20'12.62" E, 30 August 2022, M. A. Ritonga 050 (ANDA, BO); Ujong Kareung Village, 5°53'2.59" N 95°20'54.82" E, 30 August 2022, M. A. Ritonga 051 (ANDA, BO). Sukakarya Subdistrict, Paya Village, 5°48'48.99" N 95°17'55.21" E, 31 August 2022, M. A. Ritonga 058 (ANDA, BO); Iboih Village, 5°52'34.66" N 95°15'53.72" E, 31 August 2022, M. A. Ritonga 061 (ANDA, BO); Batee Shoek Village, 5°49'6.40" N 95°18'34.02" E, 31 August 2022, M. A. Ritonga 066 (ANDA, BO); Kuta Ateueh Village, 5°53'42.60" N 95°19'21.41" E, 31 August 2022, M. A. Ritonga 072 (ANDA).
Figure 4. A. D. asper; B. S. brachycladum; C. S. silicatum; and D. T. siamensis. Photos: Muhammad Azli Ritonga

Figure 5. Distribution of A. D. asper; B. S. brachycladum; C. S. silicatum; and D. T. siamensis. (Made using QGIS software)
Discussion

The bamboo specimens that we collected from Weh Island constitute a new addition to ANDA and BO’s collection from that location since there were no bamboo specimens collected from the island in ANDA and BO before. Based on these specimens, there were four genera and eight species of bamboo found on Weh Island, namely *B. multiplex*, *B. spinosa*, *B. tuldooides*, *B. vulgaris*, *D. asper*, *S. brachycladum*, *S. silicatum*, and *T. siamensis*. *B. vulgaris* was the most frequently found (16 collection numbers), meanwhile, *B. multiplex* and *B. tuldooides* were the least found (1 collection number respectively) on Weh Island. Therefore, *B. vulgaris* was widespread and the most abundant species on Weh Island. This was in line with some studies which stated that *B. vulgaris* were also abundantly found in the Banggai Kepulauan (Damayanto and Rahmawati 2020), Sulawesi (Ervianti 2019a), Lombok (Damayanto et al. 2020b), and Tenggulun District, Aceh (Ritonga et al. 2020).

Plants thrive abundantly in areas with the right climate, soil quality, and water availability. However, *B. vulgaris* stands out from other plants, as it can survive in less-than-ideal environments such as extremely humid or dry areas (Dransfield and Widjaja 1995b). It can even adapt to flooded areas for several months (Widjaja 2001) or grow well on degraded soils containing tin (Dransfield and Widjaja 1995b). This makes *B. vulgaris* capable of withstanding challenging environmental conditions. Despite not having a straight culm, *B. vulgaris* is the most commonly used bamboo species (Dransfield and Widjaja 1995b). People may have intentionally planted and cultivated it for commercial or subsistence purposes, leading to its spread and abundance in certain areas. Due to its versatility, *B. vulgaris* is used in various applications. In summary, the adaptability of *B. vulgaris* to challenging environments, intentional cultivation by people, and its versatility in various applications, all contribute to its abundance in certain areas.

Bamboo species in Weh Island are around 10.5% of all bamboo species in Sumatra (76 species) (Widjaja 2019) and around 4.5% of all bamboo species in Indonesia (175 species) (Damayanto and Fefirenta 2021). The bamboo genera on Weh Island are around 33.3% of all bamboo genera in Sumatra (12 genera) (Widjaja 2019) and around 16.6% of all bamboo genera in Indonesia (24 genera) (Damayanto and Fefirenta 2021). The diversity of bamboo species on Weh Island is quite high compared to several small islands in Indonesia (Figure 6). For example, Peleng Island in Sulawesi with an area of 2,340 km² has eight species and six genera of bamboo (Damayanto and Rahmawati 2020) and Selayar Island in Sulawesi with an area of 1,357 km² has nine species and four genera of bamboo (Liana et al. 2017), while on Pulau Weh with an area of only 120.7 km² (PKS 2023) has eight species and four genera of bamboo. Compared with the diversity of bamboo species on small islands in the Sumatra region, such as Bengkalis Island and Rupat Island, the diversity of bamboo species on Weh Island almost matches those of the two islands even though Weh Island is only 7.9% to 12.8% of the area of Rupat Island and Bengkalis Island. In detail, Rupat Island with an area of 1,524 km² (DPPKI 2023) and Bengkalis Island with an area of 938.4 km² (BPSKB 2018) were found nine species of bamboo (versus eight species on Pulau Weh) respectively (Rijaya and Fitmawati 2019; Fitmawati 2021).

Bamboo diversity can be affected by the size of an area, with larger areas generally having more habitats and ecosystems to support more species. However, bamboo diversity can also vary greatly within a small area, as shown in the data in Figure 6. In addition, the island’s unique combination of temperature, rainfall, humidity, sunlight, and geological conditions may contribute to its diverse bamboo species. On the other hand, historical and cultural context can also play a role in increasing bamboo diversity. For example, some islands having a rich history of human settlement leading to the introduction of different bamboo species on the island over time. There is a need for more research to understand these factors fully. However, one possible explanation for the variation in species diversity among small islands is the differences in bamboo exploration and survey methods conducted on each island. Limited exploration to survey bamboo on the islands can also affect species diversity data. For instance, a flora survey conducted on Peleng Island in 2014 only reported one species of bamboo found there (Rahmadi et al. 2014), but a more intensive survey in 2019 discovered eight bamboo species on the same island (Damayanto and Rahmawati 2020). A similar situation happened on Lombok Island. The first survey reported only one bamboo species (Rustiami and Sulistyaninggis 2020). However, a more intensive survey later found 11 bamboo species (Damayanto et al. 2020b), adding to the diversity of bamboo species on the island. Understanding bamboo diversity requires a multidimensional approach, considering geological and climate conditions, historical and cultural context, and exploration methods.

Most bamboo species on Weh Island are commonly found in the Sumatra region or even in other areas in Indonesia (see Widjaja 2019). However, based on this research, we reported that *S. silicatum* could be found on satellite islands of the Sumatra region. *Schizostachyum silicatum* was first described as a new species from Pariaman, West Sumatra by E. A. Widjaja in 1997 and reportedly distributed in Sumatra, Java, and Bali (Widjaja 2019). However, this species has never been officially reported outside the mainland in Sumatra, such as on Bengkalis Island (Rijaya and Fitmawati 2019) or Rupat Island (Fitmawati 2021). Based on herbarium specimens of *S. silicatum* collected from Sumatra at BO, this species was recorded in Aceh, North Sumatra, West Sumatra, Jambi, Lampung, and Bangka Island. The presence of *S. silicatum* on satellite islands of Sumatra Island, such as Weh Island and Bangka Island, is additional information on the expansion of this species distribution outside the mainland of Sumatra.

Most bamboo species on Weh Island were found in or near settlements and plantations, meanwhile, some species were found in forests (Figure 7). For example, *B. multiplex*, *B. tuldooides*, and *D. asper* on Weh Island were only found growing in or near settlements (Figure 7). *B. multiplex* and
B. tuloides were often used as ornamental plants (Widjaja 2001) due to B. multiplex having relatively small culm and leaves, and the clumps being easy to trim and shape, meanwhile, B. tuloides has beautifully inflated internodes when planted in dry soil or pots. D. asper, meanwhile, was known to have high benefits, such as young shoots for vegetables and culms for building construction materials and furniture (Widjaja 2001). Therefore, it is not surprising that these species are more often found in settlements.

![Figure 6](image.png)

**Figure 6.** Comparison of genera and species diversity of bamboo in several small islands in Indonesia. Source: research data, Liana et al. (2017), BPSKB (2018), Rijaya and Fitmawati (2019), Damayanto and Rahmawati (2020), Fitmawati (2021), DPPKI (2023), PKS (2023)

![Figure 7](image.png)

**Figure 7.** Overlapping map of land cover and species distribution of bamboo on Weh Island (made using QGIS software with modification)
B. spinosa, B. vulgaris, S. brachycladum, and T. siamensis on Weh Island were found growing in plantations, besides in settlements (Figure 7). The plantations on Weh Island are usually dryland agriculture mixed with shrubs. B. spinosa, B. vulgaris, and S. brachycladum have been reported to be able to grow in dry areas (Widjaja 2001). In Lombok, B. spinosa is well-adapted in the dry areas (Damayanto et al. 2020b). B. vulgaris, even though, reportedly grows in areas with a severe dry season where the plants become completely defoliated. Meanwhile, the natural habitat of T. siamensis is reportedly a dry forest on poor soil. Thus, it is reasonable for these species to be found in dry plantation areas. On the other hand, S. silicatum and T. siamensis on Weh Island were also found to grow in the forests. S. silicatum is commonly found in forests (Widjaja 2001) and T. siamensis in its natural habitat is also found in the semi-evergreen forest (Duriyaprapan and Jansen 1995).

Some bamboo species on Weh Island grew in a fairly wide range of altitudes, such as B. vulgaris and T. siamensis at 1-212 m asl (Figure 8A-B). It is similar in Lombok, where B. vulgaris grew at the widest range of elevations (Damayanto et al. 2020b). On the other hand, B. multiplex and B. tuloides on Weh Island were found at the narrowest and fairly low altitude at 14 m asl (Figure 8A-B). Both species are apparently not considered useful, so they are not cultivated massively. In contrast to B. vulgaris, which is widely cultivated and fairly useful in the daily life of rural communities, B. multiplex is known as an ornamental bamboo. Hence, its distribution is mostly in settlements in the lowlands of Weh Island.

After analyzing the similarity of 28 morphological characters (Table 2) using UPGMA and Nei & Li’s coefficient, bamboo on Weh Island can be clustered into four groups (A, B, C, and D) with a similarity value of 0.6 or 60%, as displayed in Figure 9’s dendrogram. Bambusa species, except for B. vulgaris, such as B. multiplex, B. spinosa, and B. tuloides, are clustered in group A, while B. vulgaris is grouped with D. asper in group B. Schizostachyum species, including S. brachycladum and S. silicatum, cluster in group C, and T. siamensis stands alone in group D. T. siamensis is distinctly different from other species because of its morphology, such as culm-sheath auricles without bristles and linear leaves, whereas other species typically have auricles with bristles on their culm-sheaths and lanceolate to oblong leaves. Schizostachyum can be quickly identified by its branch complements, which consist of several sub-equal branches, while Bambusa, Dendrocalamus, and Thyrsostachys have one dominant branch and several smaller branches. Therefore, S. brachycladum and S. silicatum are separate from other species and grouped together in group C.

On the other hand, while many species of Bambusa are grouped together, not all of them belong in the same cluster. For instance, B. vulgaris and D. asper are grouped together (group B). Bambusa and Dendrocalamus are reported to be closely related sister genera that are difficult to separate phylogenetically (Goh et al. 2010). However, both genera can be distinguished morphologically from each other. Bambusa culms, particularly young culms, are somewhat zigzagged and have branches growing close to the ground, and aerial roots only emerge from a few culm nodes close to the ground. In contrast, Dendrocalamus culms are relatively straight, with branches starting from higher up on the culm, and aerial roots emerge from almost all culm nodes. B. vulgaris and D. asper are classified together due to certain morphological characteristics, such as culm ≥10 m tall, culm-sheath ligules are toothed, culm-sheath ≥15 cm length, and leaf-blade ≥30 cm length. In the field, B. multiplex and B. tuloides are often found less than 10 m tall. Both species are often used as ornamental plants or grown in pots (Widjaja 2001), resulting in stunted growth due to pruning or growing in small pots with low nutrient. However, B. multiplex reportedly can grow up to 7 m tall (Dransfield and Widjaja 1995a) and B. tuloides can reach 10 m tall (But and Chia 1995), and the author (IPGPD) once found B. multiplex growing up to 6 m tall in the “Eka Karya” Bali Botanic Garden. Bambusa species that cluster together (B. multiplex, B. spinosa, and B. tuloides; group A) share the same morphological characters, such as green culm, culm-sheath less than 30 cm width, culm-sheath blades less than 5 cm width, and leaf-blade less than 30 cm length.

Figure 8. A. Overlapping map of altitude and species distribution (made using QGIS software with modification). B. Altitude distribution of bamboo species on Weh Island
It can be concluded that there are eight species of bamboo on Weh Island, namely B. multiplex, B. spinosa, B. tuldoides, B. vulgaris, D. asper, S. brachycladum, S. silicatum, and T. siamensis. B. vulgaris is most abundant and widespread on Weh Island, meanwhile, B. multiplex and B. tuldoides are the least common. The presence of S. silicatum on Weh Island and Bangka Island was additional information on the expansion of these species distributions outside the mainland of Sumatra. Bamboos on Weh Island were found around settlements, plantations, and forests at 1-212 m asl. Bamboo species on Weh Island can be clustered into four groups based on their morphological characteristics.

ACKNOWLEDGEMENTS

The author (MAR) would like to thank the Indonesia Ministry of Education, Culture, Research and Technology (KEMENDIKBUDRISTEK) and the Indonesia Endowment Funds for Education (LPDP) for providing scholarships (number: 0766/15.2.3/BP1.06/10/2021). Furthermore, the author (MAR) would like to express my deepest gratitude to Serka Syamsul Bahri, Permadi Saputra, Thoriq Alfath Febriamansyah, Mahdi Mutashim, Nazifah Rahmi, Nadyatul Khaira Huda, and the communities of Weh Island for the help during fieldwork and research. The authors also thank the Head of Herbarium Bogoriense, National Research and Innovation Agency and Herbarium Andalas for permission to conduct research.

REFERENCES


Figure 9. Dendrogram of bamboo species on Weh Island based on UPGMA and Nei & Li’s Coefficients