



RESEARCH ARTICLE

An updated checklist of the vulnerable bamboo *Schizostachyum* (Poaceae: Bambusoideae) in the Bukit Barisan Selatan National Park, Sumatra, Indonesia

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Abstract

The current study examines the genus *Schizostachyum* in the Bukit Barisan Selatan National Park (BBSNP) in Sumatra, Indonesia. This bamboo genus is native to Indonesia and is one of the most diverse in Sumatra. The BBSNP is recognized as a World Heritage Site. However, the current data of *Schizostachyum* spp. in Sumatra, especially in the BBSNP area, has not been well documented. The study of *Schizostachyum* at the BBSNP needs to be done. The field survey was conducted in December 2022 and June 2023 using the exploration method to explore and record the *Schizostachyum* bamboo. The survey was undertaken in three resorts, namely Sukaraja Resort, Pemerihan Resort and Balik Bukit Resort. The results discovered five *Schizostachyum*, namely *Schizostachyum brachycladum*, *Schizostachyum caudatum*, *Schizostachyum* cf. *silicatum*, *Schizostachyum zollingeri* and an unidentified species. A novel candidate was found scrambling in the hills along the river area of the enclaved village and spreading to the secondary forest of Kubu Perahu, Balik Bukit Resort. This paper offered an updated checklist of *Schizostachyum* spp. from BBSNP, including the proper botanical name, synonyms, local name, locality of occurrence and citation of voucher herbarium specimens.

Keywords: biodiversity; conservation; endemic; *Schizostachyum*; wild bamboo

Introduction

The fascinating rainforest of Bukit Barisan is home to a diverse flora, including many endemic taxa and provides the habitat for several endangered and rare animals. Unfortunately, the Bukit Barisan Forest Ridge experiences the fastest rate of land cover change in Sumatra. The diversity of plants in this area is facing an increasingly serious threat of extinction due to rapid expansions of logging and agriculture. Deforestation, especially in hilly and mountain forests, has gradually risen in recent years (1). Hence, biodiversity loss has emerged as the most significant issue for biological.

Bamboo is among Sumatra's most diverse floras, particularly on the ridge of Bukit Barisan Mountain. Sumatra has a higher diversity of bamboo than other Indonesian islands. The current record of bamboo in Sumatra comprises 14 genera, of which 7 are native and seven are introduced genera (2, 3, 4). The exploration and expedition of flora in Bukit Barisan Mountain are limited because some regions are protected areas. Among the most noteworthy is the Bukit Barisan Selatan National Park (BBSNP) region. UNESCO designates the tropical rainforest of Bukit Barisan Selatan as a

world heritage. A study of bamboo in BBSNP was done by Arpan in 1996. During her research, she found three species of *Schizostachyum*, namely *S. brachycladum*, *S. bamban* and *S. bracteum* (unpublished species). She also saw several species of other genera and a new species of *Dinorchloa*, but she never published this new species (5). After that, no one explored and published bamboo in Bukit Barisan Selatan National Park.

Schizostachyum is a native genus in Indonesia. Sumatra has the most significant number of *Schizostachyum* (18 of 28 species occur on this island). Its unique geographical position also gives Sumatra a very high level of endemism. Ten among eighteen species of *Schizostachyum* are endemic to this island (6). *Schizostachyum* is an essential and fascinating bamboo plant group that offers significant ecological, cultural and economic benefits. This bamboo inventory in such areas of Sumatra races with their extinction. This is one of the reasons why examining *Schizostachyum* in the Bukit Barisan Selatan National Park is necessary, especially before the endemic or native bamboo disappears.

Materials and Methods

Study location

The Bukit Barisan Selatan National Park (BBSNP) is situated in the southernmost part of the Bukit Barisan Mountain range, located between 04° 33' S - 05° 57' S latitudes and 103° 23' E - 104° 43' E longitudes. The field trip was conducted in two series. First, the fieldwork was undertaken in November 2022 along the Trans-Sumatra Highway, which runs along the forest border of the Bukit Barisan. Then the second field trip was done in June 2023, in the remnant forest area at Way Cangkuk Research Station (WCRS). All of the field locations include the three BBSNP resorts. There were Sukaraja Atas Resort, Pemerihan Resort and Balik Bukit Resort. The research location is in the middle of the park's northern part, consisting of the hills, rain forest and lower mountain forest ecoregions.

The Bukit Barisan Selatan National Park features highly diverse topography, heights up to 1964 m above sea level, including flat, sloping, undulating, steep hills and mountainous terrain. While the western slope into the Indian Ocean is mild, the eastern slope is relatively steep. Based on Sumatra's soil capability and slope characteristics, this national park region is unstable since it is within the central Sumatran fault zone (Semaka Fault Zone). Temperatures fluctuate between 22 °C to 35 °C. The rainfall is seasonal, averaging between 3,000 and 4,000 mm per year. The rainfall period runs from November to April, whereas the dry period occurs from June to August (1, 5). The western part receives more precipitation than the eastern part. The Bukit Barisan Selatan National Park is shaped narrowly and has a more than 700 kilometers. Villages, farms and plantations surround it.

Field and herbarium methods

Specimens were collected during field trips using the explorative method for collecting plant material in taxonomical studies (7). Plant materials from the field were preserved and observed at the Biology Department of the University of Brawijaya. The herbarium specimens were made in three duplicates of the voucher specimens and deposited in the Herbarium of the University of Brawijaya (MUBR). The location coordinates, habitat, vernacular name and morphological characteristics (culm hair, culm shoot colour, culm with branches, culm sheath, etc.) that could be lost when processing herbaria are being documented. Subsequently, morphological data from all specimens were observed and used to determine taxa positions and describe each species.

Observing morphological characters from all specimens follows Bamboo Phylogeny Groups (BPG) (8). The flowers' morphology was examined using a stereomicroscope (Nikon SMZ 445) with a magnification of 40x. The essential characteristics observed are pseudo-spikelet, prophyll, bracteate, single floret with anther, stigma, lemma and palea, stamens and pistil structure. The vital characters were documented using a pocket camera. Thus, species descriptions were created based on those data. When the description was finished, identification keys for the genera and species were provided. Identification refers to some identification books (2, 3, 9-11). In addition, the holotype specimens kept in BO and other herbaria that can be

accessed through the online portal database have been used in identification.

Results and Discussion

Five species of *Schizostachyum* spp. were found in the study location (Fig. 1). According to our observations, *Schizostachyum brachycladum* was the most common species easily found in the Bukit Barisan Selatan National Park. *Schizostachyum brachycladum* was discovered in a massive population at the Sukaraja Atas Forest, Way Cangkuk Forest and Kubu Perahu Forest. There are two varieties of this species, namely *S. brachycladum* yellow variety (locally known as bambu gading or bamboo Bali) and the green variety (locally known as bambu leman). This bamboo is commonly planted as an ornamental plant in Sumatra.

Schizostachyum brachycladum was also discovered in the forest fragments at the Way Cangkuk Research Station (WCRS). The ecological advantage of the clumps of *S. brachycladum* in WCRS as an elephant grazing area was a genuine surprise. The interaction between the elephants (*Elephas maximus sumatranus*) and the bamboo appears to be mutualistic. The elephants conserved bamboo by helping to spread away the remaining bamboo culm as their food waste and dividing it into an expanded portion on the ground. So that they would have access to the new clump when the remaining bamboo culm emerged. The newly sprouting bamboo has been discovered to be a favourite diet for the elephant. Many studies in Asia reported that Elephants prefer mixed secondary forests to primary forests for their habitat, as their forages are abundant in the mixed secondary forest (14, 15). Early successional plants in secondary forests and bamboo constitute a higher proportion of the elephants' diet than late successional plants (16).

A significant population of *Schizostachyum zollingeri* was discovered on the edge of the cliff along the trans-Sumatra Highway (Kota Agung to Krui) at the Pemerihan Resort. *Schizostachyum* cf. *silicatum* was spotted in bloom on the border of the Kubu Perahu forest, along the trans-Sumatra Highway (Liwa to Krui, 500 m from Way Sinda), Balik Bukit Resort. *Schizostachyum caudatum* was planted next to the Bukit Barisan Selatan National Parks' Region II office building, Balik Bukit Resort. Additionally, this bamboo is grown in several places, including the Balik Bukit Resort. A novel species candidate (*Schizostachyum* sp1.) was scrambling in the hills adjacent to the stream of Way Sepunti at this parks' enclave village. The population was spreading to the Kubu Perahu forest, Balik Bukit Resort.

These five species, presented in Table 1, comprise four species characterized as erect and densely clumping bamboo and only the *Schizostachyum* sp. possesses a scrambling habit. *Schizostachyum* spp. were classified into three categories according to their habits and culm shoot features (12). The first group has an erect culm with a nodding tip. The second group often features an erect culm with a dropping tip. The third group is erect while young and leans over with long drooping tips when old. All those characteristics were present in the *Schizostachyum* spp. Discovered in the Bukit Barisan Selatan National Park.

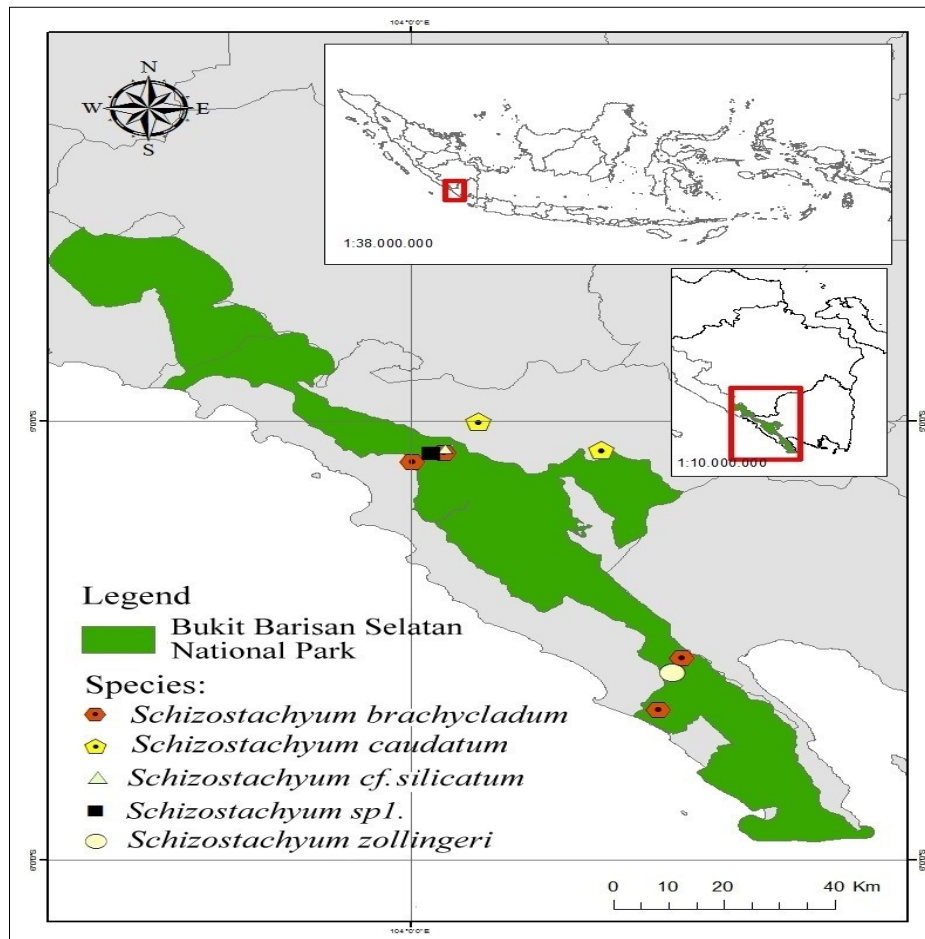


Fig. 1. Distribution of *Schizostachyum* spp. in the study location

Table 1. The *Schizostachyum* bamboo in BBSNP, Sumatra, Indonesia

Species name	Habit	Population Status	Location occurrence [*]			
			1	2	3	4
<i>Schizostachyum brachycladum</i> green variety	Erect	Wild	√		√	√
<i>Schizostachyum brachycladum</i> yellow variety	Erect	Wild				√
<i>Schizostachyum caudatum</i>	Erect; Densely clumps	Culta; Vulnerable				√
<i>Schizostachyum zollingeri</i>	Erect	Wild		√		
<i>Schizostachyum cf. silicatum</i>	Erect culm with dropping tip	Wild; Vulnerable				√
<i>Schizostachyum</i> sp 1.	Scrambling	Wild; Vulnerable				√

The bamboo populations found at the study location mostly grow wild and only *S. caudatum* is a planted clump. This is because *S. caudatum* naturally grows in a minimal area in the Mt. Pesagi, Balik Bukit District, West Lampung. In particular, *Schizostachyum cf. silicatum*, *Schizostachyum caudatum* and *Schizostachyum* Sp1 are among the rare and vulnerable species that can be found in the Bukit Barisan Selatan National Park area. *Schizostachyum* spp. typically grows wild in disturbed or logged forests, hillsides, or humid sloping regions (9). This wild bamboo population has beneficial environmental services, such as increasing water absorption, preventing floods and cliff landslides, windbreaks, animal habitats and feeding grounds and other ecological functions (11, 13).

Another species, namely *Schizostachyum bamban*, was discovered by Arpan (1996) at Sindalapai and Kubu Perahu Forest (5). We also found this species in a small population somewhere along the Trans-Sumatra Highway, Balik Bukit Resort, in 2019. Upon further inquiry, this species was not found in the most recent survey in 2022 because its population in the Bukit Barisan Selatan National Park might have gone due to over-exploitation. Local people usually use

this species to make basketry and palupuh (plaited walls) in Lampung traditional houses.

Taxonomic treatment

Schizostachyum Nees

Nees. Agrost. Bras. 2: 354. 1829; Backer CA. Handb. Fl. Java 2: 284. 1928. Holttum, Gard. Bull. Sing. 16: 147.1958

Type: *Schizostachyum blumei* Nees.

Sympodial, densely or loosely tufted bamboo. Culm erects with a nodding or a drooping tip, or erect with a long dropping tip when young and leans over with age; long internodes (up to 1.5 m); small diameter (1-4-(8) cm); thin-walled culms (1-2 mm). Branches subequal. Culm sheath is broadly triangular with an erect blade or narrow with a deflexed blade; auricles present; bristly or absent; ligule with or without bristles. Leaf blade with bristly auricles; ligule short; with or without bristles. Inflorescences are indeterminate; pseudospikelets are slender; bracts are substitutes for glumes; 1-2-(4) fertile florets; and lodicules are present. Ovary slender or ovoid; glabrous or hairy; styles persistent; white to yellowish or purplish stigma. Stamen six: filaments free or fused into a tube, anthers apiculate.

Distribution

The geographic distribution spread from South China to Southeast Asia, then Malaysia to the Pacific.

Habitat

Typically found in humid, hilly spots or on hill slopes, wild in disrupted or logged-over forests.

Key to the species

1 a. Loosely tufted bamboo, culms erect while young and leans over with a long drooping tip when old, big and hairy pseudospikelets: *Schizostachyum* sp1.

b. Densely tufted bamboo, culms erect with nodding or dropping tip, pseudo spikelets hairy or glabrous:2

2 a. Culm sheath narrow, long deflexed blade, rim-like auricles:*Schizostachyum* cf. *silicatum*

b. Culm sheath broadly triangular with an erect blade, lobed auricles:3

3 a. Sheath covered with light brown hairs, auricles 3 mm high, ligule glabrous:*Schizostachyum brachycladum*

b. Sheath covered with dark brown hairs, large auricle (up to 7 mm high), ligule hairy:4

4 a. Internodes up to 80 cm, thin-walled culms:*Schizostachyum zollingeri*

b. Internodes short 10–20 cm, solid culms or very small lumen: *Schizostachyum caudatum*

Schizostachyum brachycladum (Kurz ex Munro) Kurz

J. Asiat. Soc. Bengal 39, 2: 89.1870; Holttum, Gard. Bull. Singapore 16: 147. 1958

Type: leg. ign. s.n., K000290786 (K! -Syntype) Java, Bogor; leg. ign. s.n., K000290787 (K! -Syntype) Java, Hort. Bogor.

Basionym: *Melocanna zollingeri* var. *brachyclada* Kurz ex Munro in Trans. Linn. Soc. London 26: 134. 1868.

Densely tufted bamboo. Young shoots are green or yellow, covered by light brown hairs and their blades are brown. Culm erect 8–15 m high, nodding tip. Subequal branches emerge 1.5 m above the ground. Scattered white hairs cover young culms; caducous, mature culms become glabrous and appear greyish-green or whitish-yellow with green stripes. Light brown hairs cover the culm sheath; more persistent; the auricles resemble small lobes with prominent, long bristles; the blade is erect with a triangular base. The leaves are hairy on the abaxial surface but become glabrous as they age; the auricles are small with long bristles.

Vernacular names

Green variety: buluh nipis (Palembang), buluh leman (Malay), buluh tolang or buluh lomang (North Sumatra). Yellow variety: tiying gading (Bali), bambu Bali, bambu gading (Indonesia). These bamboos presented in Fig. 2.

Uses

The green variety is commonly used as a container for cooking leman rice. People in Sumatra, Kalimantan, Sulawesi, Moluccas and Papua consume this traditional food. The yellow variety is a fascinating focal point in the garden, both indoor and outdoor ornamental plants. The colour of the culms of this bamboo species may be related to prunin and rhoifolin levels. Prunin and rhoifolin belong to the flavanone and flavone colour classes of flavonoids. These



Fig. 2. *Schizostachyum brachycladum* (Kurz) Kurz. A. The wild clump at The Bukit Barisan Selatan National Park, B-C. The culm sheath, D. Leafy branch.

pigments accumulate during flavonoid synthesis, influenced by the expression of the PvGL, PvUF7GT and PvC12RT1 genes. The increased expression of the genes will accumulate more pigments, considerably boosting the yellow tone of bamboo culms (17).

Distribution

Southeast Asia - Thailand, Malaysia, Indonesia.

Habitat

Disturbed secondary forest, occasionally grown in primary forest, at heights up to 600 meters.

Additional specimens examined

YR0122, YR0126, YR0127

Schizostachyum caudatum Backer ex K. Heyne

in C.A. Baker, Handb. Fl. Java 2: 284. 1928.

Caespitose, densely tufted bamboo. Young shoots green, hairy. Culm erects up to 8 m tall; nodding tip; 1.5-4 cm in diameter; internodes 10-20 cm; solid or narrow lumen. The culm sheath is light green with an orange-tinged, covered by dark brown hairs; the blade is erect and broadly triangular, with a big lobbed auricle with long bristles. Inflorescence terminal; slender pseudospikelet. The caryopsis averages about 6 mm in size; the style is long and persistent; the thick pericarp separates effortlessly from the seed.

Vernacular name

It is well-known as kawoh bingkok, Buluh bungkok (Lampungense), bambu buta or bambu buntu (Bahasa Indonesia). This bamboo presented in Fig. 3.

Uses

The folks who live in the foothills of Mt. Pesagi consider this bamboo sacred, protecting against evil influences. The culm makes sticks and showcases them at Lampung customary events (Sekugha festivals). From the locals' perspective, anyone who retained this bamboo stick would be endowed with dignity, a strong body and a calm face. According to scientific views, this bamboo' function is to give people muscular bodies and a calm face while protecting them against evil influences due to the chemical compounds in bamboo species. Phenolic compounds, including flavonoids and polyphenols, are the primary metabolites in bamboo (18, 19). Flavonoids have an excellent capacity to neutralize free radicals (18, 20). Another phenolic class has varied biological activities, mainly antioxidant and anticancer and is used in cardiovascular and neurological degenerative treatments and antiaging potential (18).

Distribution

Schizostachyum caudatum is endemic to Pesagi Mountain.

Habitat

This bamboo can grow from the lowlands to 1000 m altitude.

Additional specimens examined

YR0130, YR0131

Schizostachyum silicatum Widjaja

Reinwardtia 11:145. 1997.

Type: Kurz s.n. (BO! -Holotype), Sumatra, Priaman.



Fig. 3. *Schizostachyum caudatum* Backer ex Heyne A. The cultivated clump at the Bukit Barisan Selatan National Parks' Region II office building, B-C. The culm sheath, D. The subequal branches, E. Leafy branch, F. Inflorescence

Densely tufted bamboo. White hairs cover the green young shoots. The branches emerge 1.5 m above the ground. The erect culm is up to 7–12 m high; dropping tip; internodes 65–75 cm long; 1–3 cm in diameter; culm walls are up to 3 mm thick; nodes not prominent. The culm sheath is long, covered by white hairs, apex truncate, pale brown to brown ciliate margins and junction horizontal. The blade is early caducous, deflexed; linear to narrowly triangular, longer than half long of the sheath, narrow base; and adaxially slightly hairy. The auricles are inconspicuous, with long bristles up to 3 mm; the ligule denticulates up to 1 mm high and the bristles are fine and easily break. Inflorescence terminal; 4–6 clusters or 1–many pseudospikelets; central axis hairy. Pseudospikelets glabrous 12–20 mm long; slender; one fertile floret; rachilla internode slightly hairy, approximately 5 mm long; lodicules absent. Anthers varied from Yellowish to greenish. Stigmas white.

Vernacular name

Buluh suling, aur (West Sumatra), tamiang (Bangka, Lampung), bambu suling (Bahasa Indonesia). This bamboo presented in Fig. 4.

Uses

Certain bamboo species are known to be silica accumulators. The ability of bamboo to accumulate Si varies according to soil bioavailability and phenotypic and genetic diversity (20). This species is perhaps one of the silica-rich species (*silicatum* means contents of silica). Although this hypothesis requires further investigation, this bamboo has the potential to be

employed as a medicinal agent. In our rural community, this bamboo is used to make a flute and other everyday household items.

Distribution

Schizostachyum silicatum is endemic to Sumatra, Bali and Java.

Habitat

The species was discovered at the borders of forests in the humid tropics, village roads, river banks and hillside terrain in the lowland.

Additional specimens examined

YR0128

Schizostachyum zollingeri Steud

Syn. Pl. Glumac. 1: 332. 1854.

Type: Zollinger 3529, P00633846 (P! -Holotype) Java.

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

Densely tufted bamboo. Young shoots are green. The culm reaches a height of 15 m, erect with a nodding tip; the young culm has white wax. The internodes are up to 40 (occasionally up to 55) cm long; diameter 2–7 cm; thin walls 4–7 mm; nodes not prominent. The culm sheaths are brown and persistent, covered by dark brown hair; the blade is erect and shorter than the sheath. The auricles are rounded, 0.5–1 cm long with bristles 1–2–(4) cm long; the ligule is entire, 1 mm long, glabrous or slightly hairy. Inflorescence terminal; 4–6



Fig. 4. *Schizostachyum silicatum* Widjaja. A. The wild clump at the Bukit Barisan Selatan National Park, B-C. The culm sheath, D. Leafy branch with terminal inflorescence

clusters of pseudospikelets. Pseudospikelets are tiny and slender.

Vernacular name

buluh nipis, buluh telor, buluh kasap, buluh kecai (Sumatra); awi talang or awi tjangkotok (West Java), Pring lampar or Rampil (East Java). This bamboo presented in Fig. 5.

Uses

The locals utilize this species to make galah and traditional basketry. The young shoots are edible but not widely consumed. In Central Sumatra, a group burns bamboo clumps to obtain biga or "tabashir" material. Tabashir is a dried, resinous secretion with exceptionally high silica concentration (up to 85% silica) from bamboo stems. It is used to treat children's feverish diseases, rheumatoid and epilepsy (21).

Distribution

Southeast Asia - Laos, Vietnam, Malaysia, Indonesia (Sumatra, Java).

Habitat

Evergreen rainforest, typical in secondary forests, disturbed mixed forest, forest edges and clearings at low elevations.

Additional specimens examined

YR0123

Schizostachyum sp1.

Loosely tufted bamboo. Scrambling habit. Culms are erect with long drooping tips while young and lean over to

scrambling when old. Young shoots green; brown culm sheaths covered with white hairs. Young culm having scattered white hairs. Internodes 25-40 cm long; diameter 1-2 cm; nodes having conspicuous black girdle. Culm sheath persistent; blade spreading- deflexed. Auricles are large and curved outward; long bristles; ligule is an entire 1 mm; hairy. Inflorescence: big terminal and hairy pseudospikelets.

Vernacular name

Buluh cacing. This bamboo is presented in Fig. 6.

Distribution

Bukit Barisan Selatan National Park, Sumatra

Habitat

River banks and hill slopes in the rainforest.

Specimens examined

Rahayu YR0129, Sumatra, Way Sepunti.

Note

This species is distinguished by its long and drooping tip. It leans over when old. Internodes 25-40 cm long; nodes with conspicuous black girdle. Culm sheath persistent; blade spreading-deflexed. Auricles are large, curved outward; long bristles. Inflorescence: terminal, big and hairy pseudospikelets.

S. bracteum is found in the Bukit Barisan Selatan National Park, with its collection number 8R (5). The specimen of *S. bracteum* was not examined during this study. However, the description says that this species has a deflexed blade and is closely related to *S. lima*.



Fig. 5. *Schizostachyum zollingeri* Steud. A. The clump at the Bukit Barisan Selatan National Park, B. The culm is covered with white wax and young shoots, C. The culm sheath, D. Terminal inflorescence.

Conclusion

According to the current research, the results showed that five species of *Schizostachyum* occur in the studied location (Bukit Barisan Selatan National Park). They were *S. brachycladum*, *S. caudatum*, *Schizostachyum* cf. *silicatum*, *S. zollingeri* and *Schizostachyum* sp1. Future attention should be paid to collaborating on effective conservation strategies and sustainability prospection of these vulnerable species. A multidisciplinary research is urgently needed to reveal the potency of each species. So, bamboo biodiversity can be more valuable in improving the community's life. The bamboo cultivation land is essential to support future industries and to ensure the survival of wild bamboo in the face of pressures from human activities.

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Authors' contributions

YR carried out the field trip and morphological observations, drafted the manuscript and provided the revision. RA participated in the design and conceptualization of the study

and in drafting and revising the manuscript. GWL conducted the data curation and participated in the revised manuscript. ELA conceived of the study and participated in its coordination. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest : The authors do not have any conflicts of interest to declare.

Ethical issues: None

Declaration of generative AI and AI-assisted technologies in the writing process

While preparing this work, the author(s) used the Grammarly Tool to improve language and readability. After using this tool, the author(s) reviewed and edited the content as needed and take full responsibility for the publication's content.

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Fig. 6. *Schizostachyum* sp1. A. The scrambling clump at the Bukit Barisan Selatan National Park, B. Leafy branch, C. Terminal inflorescence: large and hairy pseudospikelet, D. Young shoot, E-F. The culm sheath spreads to a deflexed blade, a large auricle and long bristles

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