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Identification Morphology of Bamboo, and Traditional Use in Gorontalo

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Abstract. *Bamboo is a versatile plant that has many benefits in the lives of the people of Gorontalo. This research aims to provide taxonomic information on bamboo species in Gorontalo Province, including variations in morphological characters and phenetic relationships of bamboo, as well as information on the traditional use of bamboo. The method used in this research is exploration and interviews. Exploration was carried out to collect information on bamboo taxonomy, while interviews were conducted to find out the use of bamboo by the Gorontalo Community. The research data obtained was then analyzed descriptively to describe and interpret data on morphological variations, phenetic relationships and traditional benefits of the various types of bamboo obtained. Based on the research results, it was obtained that 13 types of bamboo are distributed in Gorontalo which show the unique morphological variations of the varieties which are divided into four genera, namely the genus Gigantochloa has distinctive morphological characteristics on the waxy surface of the stem, the Bambusa genus with characteristic shiny, smooth stems, the Dendrocalamus genus has the largest diameter and stem wall thickness, the genus Schizostachyum has the same morphological characteristics of stem segments and branch lengths. Based on the analysis of phenetic relationships, two main clusters were formed with a similarity value of 61.2%. In terms of traditional uses, it was recorded in this research that most bamboo is used as building construction materials, food sources, traditional medicine, materials for traditional ceremonies, handicrafts, and ornamental plants, as a tool designedto help people's livelihoods and ecological functions. This research also provides the first record of the morphological characteristics and use of each type of bamboo in Gorontalo which can be used for future bamboo breeding and conservation projects.*

Keywords: *Bamboo, morphology, similarity ,traditional use*

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INTRODUCTION

Bamboo belongs to the Poaceae (grass) family better known as Giant Grass. The stages of bamboo development start from bamboo shoots, young stems, and adults aged 3-4 years (Surati et al. 2022) Bamboo morphology consists of stems, roots, rhizome structures, shoots, branches, and leaves. In general, the two main parts of bamboo are divided into the rhizome and the stem system. Another grouping differentiates bamboo into underground parts (consisting of rhizomes, roots, and shoots) and above-ground parts (consist-

ing of stems, branches, and leaves) (Roslan et al. 2018). Bamboo reproduces mainly in tropical areas by rhizomes, allowing it to grow in clumps. Meanwhile, walking bamboo is often found in subtropical areas because of its long rhizome neck (Ritonga et al. 2023).

Around 75 bamboo genera are of 1,500 species spread across various parts of the world. A total of 10 genera or 125 species grow wild and are rarely used in Indonesia (Latumahina et al. 2022) . Bamboo genera distributed in Indonesia includ: *Arudinaria*, *Bambusa*, *Dendrocalamus*, *Dinochloa*, *Gigantochlea*, *Melocanna*, *Nastus*, *Phyllostachys*, *Schizostachyum*, and *Thyrsostachys* (Simatupang et al. 2013).

Bamboo has long been considered by Indonesian people as a plant that has many uses in everyday life (Sofiah & Susim, 2020). Uses for bamboo include construction (flooring, roof design, and scaffolding), furniture, food, biofuels, cloth, paper, paper pulp, charcoal, planting ornamental gardens, and environmental characteristics, such as large carbon sinks and options, good phytoremediation, improving soil structure and soil erosion (Emamverdian et al. 2020). Bamboo is also known as a habitat for animals such as the mongoose civet *Paradoxurus hermaphroditus* Pallas 1777 (civet civet) which is reported to make nests in bamboo groves in Sumba, Indonesia (Hamidy et al. 2017). Additionally, the ghost orchid, *Didymoplexis pallens* Griff, is known to grow under bamboo groves (Zulkarnaen et al. 2020).

Bamboo as a local plant of Gorontalo is one of the traditional tools in the *Mo me'ati tradition* (Halid & Novianti, 2017; Muhiddin, 2016), *Mongubingo* (Islami and Putri, 2020) , weddings (Sune et al. 2020), and evening celebrations of lighting (*tumbilotohe*) (Paneo et al. 2021) . Even several traditional game materials in Gorontalo use bamboo, such as in the games *tenggedi buau*, *tenggedi wawohu*, and *palapudu* (Hadjarati & Haryanto, 2021). Bamboo is also used to make traditional Gorontalo musical instruments, namely the Polopalo, which looks like a giant tuning fork (Febriyando, 2017).

Very high use of bamboo without being balanced with conservation could threaten genetic diversity in Gorontalo. Even though many types of bamboo have been identified to beendemic to Indonesia, there are still opportunities to explore other areas, especially in eastern Indonesia (Mentari et al. 2018) . A taxonomic study is needed to provide details regarding plant names, characteristics, characteristics specific to the plant habitat, and their relevance to scientific data from field studies.

This research aimed to identify bamboo samples in Gorontalo Province, examined their morphological characteristics, and documented their use by local communities. This research is the first record of the morphological characteristics of bamboo in this province. It is hoped that the results of this research can be a source of information in further research related to plant breeding, conservation measures, and conservation of bamboo plants in Gorontalo Province. In addition, this research will help complete data collection for all bamboo species in Indonesia.

MATERIALS AND METHODS

This research was carried out from April to May 2023. Exploration and collection of bamboo samples in Gorontalo Province was carried out in 3 districts, namely Gorontalo District, Bone Bolango District, and Gorontalo City based on information from the local community. The material used in this research consisted of 13 bamboo species found scattered in various villages in Gorontalo Province. The identified accessions are mostly plants that grow in open land near river watersheds.

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Sampling and Data Collection

Sampling was carried out in the field using a purposive sampling method considering the availability of bamboo plants at that location. Descriptions in the field were carried out by recording initial information on bamboo plants or known plant passports (field notes) in the form of the collector's name, collection number and date, local name, species name, and sample origin status (Febriyanti, 2016; Febriyanti, 2022). Information regarding the use of bamboo identified in this research was collected through direct observations in the field, and interviews with local communities and craftsmen at the research location (Sofiyanti et al. 2022).

Table 1. List of Morphological Characters for Bamboo (*Bambu* spp), (Setiawati et al. 2017; Widjaja 2001)

Morphological Characters	Methods of Assessment and Scaled Used
	Root
Root branching system	Pachymorph (0); Leptomorph (1)
	Culm
Culm color	Green (0); Yellow (1); Green/Yellow; (2); Others (3)
Culm stripes	Absent (0); Present (1); Others (2)
Culm diameter	< 7 cm (0) ; ≥ 7 cm (1)
Culm wall thickness	< 7 cm (0) ; ≥ 7 cm (1)
Culm height	< 10 m (0); ≥ 10m (1)
Culm internode length	< 40 cm (0) ; ≥ 40 cm (1)
Culm internodes surface	Glabrous (0); Pubescent (1)
Culm nodes shape	with aerial roots (0); without aerial roots (1); with culm nodes (2); without culm nodes (3)
Wax on culm	Absent (0); Present (1)
Culm position	Serrated (0); Creeping (1); Erect (2)
	Culm-sheath
Culm-sheath persistence	Caducous (0) ; Persistent (1)
Culm-sheath length	< 30 cm (0) ; ≥ 30 cm (1)
Culm-sheath width	< 30 cm (0); ≥ 30cm (1)
Shape of culm-sheath auricles	Rim-like inconspicuous (0); small(1); rounded (2)
Bristle of culm-sheath auricles	Absent (0); Present (1)
Bristle length of culm-sheath auricles	Absent (0); < 3 mm (1) ; ≥ 3 mm (2)
Height of culm-sheath ligule	< 0.5 cm (0); ≥ 0.5cm (1)
Culm-sheath ligule	Entired(0); Slightly entired (1); Lacerated (2); Toothed (3); Irregular (4); Short frame-like (5)
Bristle of culm-sheath ligule	Absent (0); Present (1)
Bristle length of culm-sheath ligule	Absent (0); < 1 cm (1) ; ≥ 1 cm (2)
Shape of culm-sheath blade	Oblong (0); Broadly lanceolate (1); Narrowly lanceolate (2); Broadly triangular (3); Narrowly triangular (4); Linear (5)
Length of culm-sheath blade	< 15 cm (0) ; ≥ 15 cm (1)
Width of culm-sheath blade	< 5 cm (0) ; ≥ 5 cm (1)
Culm-sheath hair color	White (0); Light brown (1); Black (2)
	Branches
Branch size	One dominant branch and several smaller branches (0); Several sub-equal branches (1)
Branch spines	Absent (0); Present (1)
Branch positions	Located deep in the soil surface (0); Grows about 1 m at the soil surface (1)
	Leaves
Length of lamina leaves	< 30 cm (0) ; ≥ 30 cm (1)
Width of lamina leaves	< 4 cm (0) ; ≥ 4 cm (1)
Leaf-sheath shape	Linear(0); Triangular (1) Isosceles triangular, sparsely spread, and erect (2); Equilateral triangular (3)
	Shoot
Shoot color	Light green (0); Dark green (1); Purplish (2) ; Brown (3)
Shoot hair color	Light brown (0); Attached black (1) ; White (2)

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Morphological Identification and Description

Samples obtained from collections in the field were then identified by matching the morphological data with descriptions in the literature or based on images. The identification process refers to the bamboo species identification book published by the Center for Biological Research and Development - LIPI (Widjaja 2001). Table 1 shows the observed bamboo plant characters. The interview results were analyzed by cross-checking, summarizing, and synthesizing from various sources to build a narrative report (Setiawati et al. 2017)

Data analysis

Data on the morphological characteristics of the Bamboo genus were analyzed descriptively and presented in the form of images and data tabulation. Kinship relationship analysis was carried out using MVSP (Multivariate Statistical Package) v.3.1 software to compile a phenotypic dendrogram using the Gower's General Similarity Coefficient, and Unweighted Pair Group with Mean of Arithmetic (UPGMA) grouping method (Kandowangko & Febriyanti, 2023).

RESULTS AND DISCUSSION

Types of Bamboo Found in Gorontalo Province

Based on exploration results, there were 13 types and four genera of bamboo that were collected from three districts in Gorontalo Province as shown in Table 2.

Table 2. Diversity of Bamboo Types in Gorontalo Province (Primary Data Source 2023)

Class	Order	Family	Genus	Species and Variety
Liliopsida	Poales	Poaceae	*Gigantochloa*	*Gigantochloa apus* (Schult.f.) Kurz
Liliopsida	Poales	Poaceae	*Bambusa*	*Bambusa tulda* Roxb.
Liliopsida	Poales	Poaceae	*Gigantochloa*	*Gigantochloa atter* (Hassk.) Kurz
Liliopsida	Poales	Poaceae	*Schizostachyum*	*Schizostachyum zollingeri* Steud.
Liliopsida	Poales	Poaceae	*Bambusa*	*Bambusa tuldoides* Munro
Liliopsida	Poales	Poaceae	*Bambusa*	*Bambusa glaucophylla* Widjaja
Liliopsida	Poales	Poaceae	*Schizostachyum*	*Schizostachyum blumei* Nees
Liliopsida	Poales	Poaceae	*Bambusa*	*Bambusa vulgaris* Schrad. ex JCWendl
Liliopsida	Poales	Poaceae	*Bambusa*	*Bambusa vulgaris* var. striata (Lodd. ex Lindl.) Gamble
Liliopsida	Poales	Poaceae	*Schizostachyum*	*Schizostachyum brachycladum* (Kurz ex Munro) Kurz
Liliopsida	Poales	Poaceae	*Gigantochloa*	*Gigantochloa hasskarliana* (Kurz) Backer
Liliopsida	Poales	Poaceae	*Schizostachyum*	*Schizostachyum latifolium* Gamble
Liliopsida	Poales	Poaceae	*Dendrocalamus*	*Dendrocalamus asper* (Schult.f.) Backer

Based on the table above, all the bamboo found is native Indonesian bamboo. Native genera of Indonesian bambooare Bambusa, Dendrocalamus, Gigantochloa, and Schizostachyum (Damayanto & Fefirenta, 2021). The dominant bamboo genus in Gorontalo Province is the Bambusa. Bambusa is known for its tall and strong stems, making it highly valued for construction, furniture, and various other applications. About 157 species of the genus Bambusa have been documented worldwide. Its distribution varies in tropical areas and comes from countries such as Pakistan, India, Sri Lanka, Nepal, Bhutan, Bangladesh, Burma, Thailand, Laos, Kampuchea, Vietnam, China, Japan, Malaysia, Singapore, Indonesia, Philippines, Papua, Papua New Guinea, Australia, and Madagascar. Bambusa species are abundant and grow in Indonesia, especially in areas with climatic conditions that support the development of bamboo. Bamboo from this genus can be easily distinguished from other bamboo based on its characteristics and habitat, such as densely seg-

mented, erect, hollow stems with relatively thick walls and usually glabrous. The branch consists of several branches with a dominant central branch that produces branches at each node. The stem sheath is usually covered with black hairs and well-developed auricles; the vertical blade, is usually triangular in shape. The inflorescences are borne on leafless stem branches. Distribution and habitat Bambusa bamboo is distributed in tropical areas. They are usually found growing in open areas in lowlands or on hillsides, on a variety of soil types, but are often found in damp places such as river banks (Khan & Hemalatha, 2015).

Based on research conducted by Ervianti et al. (2019), on Sulawesi Island, there are 39 species of bamboo from 12 genera. The same types of bamboo found in Gorontalo Province are *Bambusa vulgaris*, *Gigantochloa apus*, *Gigantochloa atter*, *Bambusa tuldoides*, *Bambusa glaucophylla*, *Schizostachyum brachycladum*, *Schizostachyum latifolium*, and *Dendrocalamus asper*. The other five species obtained in this study were *Bambusa tulda*, *Schizostachyum zollingeri*, *Schizostachyum blumei*, *Bambusa vulgaris* var. striata, and *Gigantochloa hasskarliana* are known to have not been recorded in previous research, so research on morphological identification of bamboo species in Gorontalo provides new information about various types of bamboo in Gorontalo.

Morphological Characterization of Bamboo in Gorontalo Province

The diversity of bamboo plant types can be known through identification activities. Identification aims to name bamboo plants at the species level through morphological characterization. Plant morphology is used as a leading tool before continuing with other methods. The use of morphological characters in this research is considered important because it can be used at all hierarchical taxonomic levels and has a greater role in determining species and other categories below that species (Ahmad et al. 2021). Data on the results of morphological characterization of 9 types of bamboo are shown in Table 3.

Bamboo morphology can be recognized from the unique rhizome roots, which grow underground and form branching structures. The stem is a reed with segments and nodes. The reed frond is formed by modified leaves connected to each segment, which consists of the reed frond, reed frond ear, and ligule. Branching is most often found at segments. The leaf blades on the bamboo stem are parallel. The petiole connects the leaf blade to the midrib (Hastuti et al. 2018) Based on table 3, each genus has its own characteristics. The *Gigantochloa* genus is characterized by a waxy stem surface, a curved midrib position, and a branching system that has one branch that is larger than the other branches. The *Bambusa* genus is characterized by its shiny, smooth stem surface, upright midrib position, and a branching system of unequal size. The *Dendrocalamus* genus is characterized by the diameter and thickness of its stem walls being the largest compared to other bamboo genera and having a branching system that is not the same size. Meanwhile, the Schizostachyum genus is characterized by its long segments and equally large branches (Hastuti et al. 2018).

Most of the bamboo found grows close to river flows. These environmental conditions support the growth of bamboo because it has high levels of humidity and the soil is rich in nutrients due to regular deposition of sediment and organic material. Apart from that, bamboo needs lots of sunlight to grow (Damayanto et al. 2023). The following is a description of 13 types of bamboo found in Gorontalo Province.

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Table 3. Data on Morphological Characterization of Bamboo in Gorontalo Province

No.	Characteristics	*G. apus*	*B. tulda*	*G. a tter*	*S. zollingeri*	*B. tuldoides*	*B. glaucophylla*	*S. blumei*	*B. vulgaris* Schrad. ex JCWendl.	*B. vulgaris* var. striata	*S. brachycladium*	*G. hasskarliana*	*S. latifolium*	*D. asper*
						Root								
1.	Branching System	Pakymorph	Pakymorph	Pakymorph	Pakymorph	Pakymorph	Pakymorph	Pakymorph	Pakymorph	Pakymorph	Pakymorph	Pakymorph	Pakymorph	Pakymorph
						Stem								
2.	Bar color	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Green	Green	Green
	Line color	There isn't any	Orange	There isn't any	There isn't any	There isn't any	There isn't any	There isn't any	There isn't any	Green	There isn't any	There isn't any	There isn't any	There isn't any
	Stem diameter	11 cm	10 cm	9 cm	11 cm	1.2cm	1.6cm	9.5cm	6.5cm	6.5cm	4 , 5 cm	9.6cm	2.5 cm	3 cm
	Wall thickness	2 cm	2.5cm	2.1cm	2 cm	0.4 cm	1.8cm	0.9cm	1.1cm	1.9cm	0.6cm _	0.4cm _	0 .1 cm	0.8cm _
	Bamboo height	22 m	50m	30m	24m	48 m	8m	27 m	23 m	26 m	10m _	10m	5m _	7 m
	Internode length	22 cm	26.5cm	27.5cm	24 cm	42 cm	18.1cm	26.5cm	44 cm	21 cm	30 cm	22.5cm	2 9 cm	36.5cm
	Segment surface	Bare	Bare	Bare	Bare	Bare	Bare	Bare	Bare	Bare	Bare	Bare	Bare	Bare
	Form a stem node	With knees	With knees	With knees	With knees	With knees	With knees	With knees	With knees	With knees	No aerial roots	With knees	With knees	With knees
	Wax on stem	There isn't any	There isn't any	There is	There is	There is	There is	There isn't any	There is	There isn't any	There isn't any	There 's no	There is	There is
	Reed position	Upright	Upright	Upright	Upright	Random	Upright	Random	Upright	Upright	Upright	Random	Upright	Upright
						Reed Fronds								
3.	Decay	Easily shed	Doesn't fall off easily	Doesn't fall off easily	Doesn't fall off easily	Easily shed	Doesn't fall off easily	Easily shed	Doesn't fall off easily	Doesn't fall off easily	Doesn't fall off easily	M has fallen	Doesn't fall off easily	Easily shed
	Length of reed frond	< 30 cm	< 30 cm	< 30 cm	< 30 cm	< 30 cm	< 30 cm	< 30 cm	< 30 cm	< 30 cm	< 30 cm	> 30 cm	< 30 cm	> 30 cm
	Width of reed frond	< 30 cm	< 30 cm	< 30 cm	< 30 cm	< 30 cm	< 30 cm	< 30 cm	< 30 cm	< 30 cm	< 30 cm	> 30 cm	< 30 cm	< 30 cm
	Reed frond ears	Invisible	Invisible	Curved out	Invisible	Small lobed	Small lobed	Invisible	Invisible	Curved out	Invisible	Curved out	Curved out	Curved out
	Auricle hairs	There is	There isn't any	There is	There is	There isn't any	There isn't any	There is	There isn't any	There isn't any	There isn't any	There is	There isn't any	There isn't any
	Length of auricle feathers	≥ 3 mm	-	≥ 3 mm	≥ 3 mm	-	-	≥ 3 mm	-	-	-	≥ 3 mm	-	-
	Ligule length	≥ 0.5cm	≥ 0.5cm	≥ 0.5cm	≥ 0.5cm	≥ 0.5cm	≥ 0.5cm	≥ 0.5cm	≥ 0.5cm	≥ 0.5cm	≥ 0.5cm	≥ 0.5cm	≥ 0.5cm	≥ 0.5cm
	Ligule shape	Rather flat	Jagged	S h o r t frame	Short frame	Flat	Jagged	Flat	Flat	Flat	Flat	Irregular	Flat	Short frame
	The length of the reed frond blade	≥ 15 cm	≥ 15 cm	≥ 15 cm	≥ 15 cm	< 15 cm	≥ 15 cm	≥ 15 cm	≥ 15 cm	≥ 15 cm	< 15 cm	≥ 15 cm	≥ 15 cm	≥ 15 cm
	Width of the reed frond blade	≥ 5 cm	≥ 5 cm	≥ 5 cm	≥ 5 cm	< 5 cm	< 5 cm	≥ 5 cm	≥ 5 cm	≥ 5 cm	≥ 5 cm	≥ 5 cm	≥ 5 cm	≥ 5 cm
	Feathers on the midrib	Black	Black	L i g h t brown	Black	Black	Black	Black	Black	White	Light brown	Light brown	L i g h t brown	Light brown
	Position of midrib	Upright	Upright	Upright	Upright	Upright	Spread	Upright	Upright	Spread	Upright	Spread	Curled back	Bump

	Branching													
4.	Branch size	One branch is bigger	One branch is bigger	One branch is bigger	One branch is bigger	One branch is bigger	One branch is bigger	One branch is bigger	One branch is bigger	One branch is bigger	One branch is bigger	One branch is bigger	One branch is bigger	One branch is bigger
	Thorns on branches	Without thorns	Without thorns	Without thorns	Without thorns	Without thorns	Small spines	Without thorns	Without thorns	Without thorns	Without thorns	Without thorns	Without thorns	Without thorns
	Branch position	Deep on the ground	About 1 m on the ground	About 1 m on the ground	About 1 m on the ground	About 1 m on the ground	About 1 m on the ground	About 1 m on the ground	About 1 m on the ground	About 1 m on the ground	Deep on the ground	Deep on the ground	Deep on the ground	Deep on the ground
	Leaf													
5.	Leaf length	18.9cm	28.4cm	30 cm	27.7 cm	9.1cm	26 cm	28 cm	30 cm	31.2cm	25.5cm	27 cm	29.5cm	35 cm
	Leaf width	2.8cm	3 cm	3 cm	2.8cm	1.2cm	3 cm	3 cm	3 cm	3 cm	4.8cm	1.8cm	5 cm	4.7
	Midrib leaf shape	Isosceles triangle	Isosceles triangle	Isosceles triangle	Equilateral triangle	Isosceles triangle	Equilateral triangle	Isosceles triangle	Isosceles triangle	Triangle with wide base	Equilateral triangle	Isosceles triangle	Linear	Isosceles triangle
	Bamboo shoots													
6.	Bamboo shoot color	Dark green	Light green	Chocolate	Light green	Light green	Dark green	Dark green	Dark green	Light green	Pale green	Chocolate	Light green	Light green
	Bamboo shoot feather color	Deep black	Deep black	Deep black	Deep black	White	Light brown	Deep black	Light brown	Light brown	White	Deep black	Deep black	Deep black

Gigantochloa apus

Bitter bamboo or string bamboo (*Gigantochloa apus*) is a bamboo species with the characteristic of upright stems and not dense clumps (Figure 1). This species can reach 20 m in height and has a 7-10 cm diameter. The stem is green with 20-50 cm segments, leaves measuring 2-7 cm with green shoots. The branching system of this bamboo is a sympodial clump, upright, and grows in humid areas (Rumahorbo et al. 2022).

Bambusa tulda

Bambusa tulda is a bamboo species that has the characteristics of upright stems and dense clumps (Figure 2). This species can reach 50 m in height and has a diameter of 9 cm. The stem is green with segments measuring 50 cm, the leaves are 3 cm wide with light green shoots covered with dark black hairs. The branching system of this bamboo is a sympodial clump, upright, and grows in humid areas. The leaves of B. tulda are 3-4 cm wide and 20-35 cm long with an oval-lanceolate shape (Bhattacharya et al. 2006).

Gigantochloa atter

Gigantochloa atter is a bamboo species that has the characteristics of upright stems and rather dense clumps (Figure 3). This species can reach 30 m in height and have a diameter of 10 cm. The stem is green with segments measuring 27.5 cm, the leaves are 3 cm wide with brown shoots covered in dark black hairs. The branching system of this bamboo is a sympodial clump, upright, and grows in humid areas. Earlobes

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are rounded with short bristles; scalloped ligule; the blade is bent, triangular in shape, and has a narrow base. Inflorescences are not available (Ervianti, Widjaja, and Sedayu 2019). Young reeds are green with scattered black hairs, when they are old, bald reeds are green to dark green. Reed fronds are covered in black hairs and shed easily when mature or old, reed fronds also have frond ears that are curved back and rounded (Jaidan et al. 2020).

Schizostachyum zollingeri

Schizostachyum zollingeri is a species of bamboo that has the characteristics of upright stems and rather dense clumps (Figure 4). This species can reach a height of 24 m and has a diameter of 1.1 cm. The stems are green with segments measuring 2-4 cm, the leaves are 2 cm wide with light green shoots covered in dark black hairs. The branching system of this bamboo is a sympodial clump, upright, and grows in humid areas. Reed fronds do not shed easily, arelight brown in color and covered with brown hairs, the ligule is flat, the leaf midrib is erect, and glabrous (Trimanto et al. 2020).

Bambusa tuldoides

Bambusa uldoides is a species of bamboo that has the characteristics of brittle stems and rather dense clumps (Figure 5). This species can reach 48 m in height and has a diameter of 11 cm. The stem is green with segments measuring 42 cm, and leaves 1.2 cm wide with light green shoots covered in white hairs. The branching system of this bamboo is a sympodial clump, upright, and grows in humid areas.

Bambusa glaucophylla

Bambusa glaucophylla is a species of bamboo that is characterized by upright stems and rather dense clumps (Figure 6). This species can reach 8 m in height and has a diameter of 1.6 cm. The stem is green with segments measuring 18.1 cm, the leaves are 3 cm wide with dark green shoots covered with light brown hairs. This bamboo branching system is a sympodial, upright clump, and is often found on hillsides, valleys, or forest edges in subtropical areas where humidity is quite high.

Bambusa textilis / Schizostachyum blumei

Bambusa textilis is a species of bamboo that has the characteristic of having hairy stems and rather dense clumps (Figure 7). This species can reach a height of 27 m and has a diameter of 9.5 cm. The stem is green with segments measuring 26.5 cm, the leaves are 3 cm wide with dark green shoots covered with dark black hairs. The branching system of this bamboo is a sympodial, upright clump, and is often found in damp areas.

Bambusa vulgaris Schrad. ex JC Wendl

Ampel bamboo is a species of bamboo that is characterized by upright stems and rather dense clumps (Figure 8). This species can reach a height of 23 m and has a diameter of 7.5 cm. The stem is green with segments measuring 44 cm, the leaves are 3 cm wide with dark green shoots covered with light brown hairs. The branching system of this bamboo is a sympodial, upright clump, and is often found in damp areas. In a number of subtropical areas in Asia, especially from China to other parts of East Asia, the expansion of ampel bamboo has been seen (Riastuti et al. 2019).

Bambusa vulgaris var. striata

Striped bamboo is a type of bamboo that has characteristic stems that are shiny green or yellow with green stripes. The stem of the reed is black, the single leaf is alternate with midrib, and the base of the leaf is round. Branches

grow above the ground with the main branch being larger than the other branches (Figure 9). This type of bamboo rarely flowers, bears fruit, and produces seeds (Wardana et al. 2022). This bamboo is widespread throughout tropical regions of the world, including Australia, Africa, America, and the Pacific.

Schizostachyum brachycladum

Schizostachyum brachycladum is a species of bamboo that is characterized by upright stems and rather dense clumps (Figure 10). This species can reach 10 m in height and has a diameter of 4.5 cm. The stem is yellow with segments measuring 30 cm, and leaves 4.8 cm wide with light yellow shoots and white hairs. The branching system of this bamboo is a sympodial, upright clump, and is often found in humid areas. The auricles of this bamboo have a small rounded shape, located on the right and left of the reed midrib leaves, with long, pointed hairs. The fronds that stick to the reeds or bamboo shoots do not fall off easily. The fronds of the reed are covered with brown hairs when they are young and the hairs will shed when they get older. S. brachycladum bamboo can grow in highland areas and in dry lowland areas. This bamboo can also grow very well in humid tropical areas (Siahaan et al. 2020).

Gigantochloa hasskarliana

Gigantochloa hasskarliana is a species of bamboo that has the characteristics of brittle stems and rather dense clumps (Figure 11). This species can reach 10 m in height and has a diameter of 9.6 cm. The stem is green with segments measuring 22.5 cm, leaves 1.8 cm wide with dark green to purplish shoots and attached black hairs. The branching system of this bamboo is a sympodial, upright clump, and is often found in damp areas. *G. hasskarliana* bamboo is usually found in highland and lowland areas. This bamboo can also grow in riparian areas because this bamboo can grow well in humid areas (riparian areas have quite humid temperatures because they are in areas near water) (Siahaan et al.2020).

Schizostachyum latifolium

Schizostachyum latifolium is a bamboo species characterized by upright stems and rather dense clumps (Figure 12). This species can reach 5 m in height and has a diameter of 2.5 cm. The stem is green with segments measuring 29 cm, and leaves 5 cm wide. The branching system of this bamboo is a sympodial, upright clump, and is often found in damp areas. This bamboo shoot is green and the stem of the bamboo shoot is light green with a brownish border. The fronds attached to bamboo shoots do not fall off easily. The auricle of this bamboo is round with a curved tip that has very long, pointed hairs. Reed fronds are brown when dry and do not shed easily. The leaves of the reed frond are long triangular in shape with a pointed tip, rolled up, and have reverse curled position. This bamboo can grow in highland areas as well as in dry lowland areas and even in critical areas. This bamboo can also grow very well in humid tropical areas (Siahaan et al. 2020).

Dendrocalamus asper

Dendrocalamus asper is a bamboo species characterized by upright stems and rather dense clumps (Figure 13). This species can reach 7 m in height and have a diameter of 3 cm. The stem is green with segments measuring 36.5 cm, leaves 4.7 cm wide with dark green to purplish shoots and attached black hairs. The branching system of this bamboo is a sympodial, upright clump, and is often found in damp areas.

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Phenoetic Relationships Among Bamboo Species Based on Morphological Characters

The results of the kinship analysis are presented in the form of a kinship dendrogram (Figure 14). Phenotic relationship analysis was carried out based on 33 representative morphological characters which were estimated to group the 13 types of bamboo observed. The dendrogram reconstruction shows two main groupings. A similarity coefficient of 61.2% (0.612) unites the two groups. Cluster I consists of 7 bamboo accessions which are grouped into 2 subclusters, namely subclusters IA and IB with a similarity coefficient of 63.9% (0.639). Subcluster IA consists of 1 accession, namely BTLGA-001, while subcluster IB consists of 6 accessions and is divided into separate subclusters IBa and IBb with a similarity coefficient of 66.9% (0.669). Subcluster I Ba consists of 5 accessions, namely *Dendrocalamus asper* (BTLGA-004), *Schizostachyum latifolium* (BTLGA-003), *Bambusa vulgaris* var. striata (BBLHU-003), *Bambusa vulgaris* (BBLU-002), *Bambusa glaucophylla* (BBNBL-006) and subcluster IBb which consists of 1 accession, namely *Bambusa tuldoides* (BBNBL-005). Cluster II consists of 6 bamboo accessions which are grouped into 2 subclusters, namely subclusters IIA and IIB with a similarity coefficient of 75.6% (0.756). Subcluster IIA consists of 1 accession, namely *Bambusa tulda* (BBNBL-002), while subcluster IIB consists of 5 accessions and is divided into separate subclusters IIBa and IIBb with a similarity coefficient of 77.8% (0.778). Subcluster IIBa consists of 1 accession, namely *Gigantochloa hasskarliana* (BTLGA-002), while subcluster IIBb consists of 4 accessions, namely *Schizostachyum zollingeri* (BBNBL-004), *Gigantochloa atter* (BBNBL-003), *Schizostachyum blumey* (BLHU-001), and *Gigantochloa apus* (BBNBL-001).

Utilization of Bamboo in Gorontalo Province

Bamboo strongly connects people's lives, especially in rural areas. People use this species to produce household goods and livelihoods. Bamboo cannot be separated from people's culture. This makes bamboo a versatile free species (Setiawati et al. 2017). Bamboo found in the forest or in the yard can be directly processed and used by the people of Gorontalo. Many people use bamboo because it is flexible, durable, and easy to prepare. The parts of the bamboo plant that are often used are the stems and shoots. The following is the use of bamboo by the people of Gorontalo.

Building Construction

Bamboo can be an alternative material for building construction besides wood because it is easily renewable and grows quickly (Hanafi et al. 2017). Bamboos that are often used as building materials include *G. apus* and *D. asper* (Putro et al. 2014). *G. apus* has flexible stems, long fibers, and is very good for tying. This flexibility makes it easy for craftsmen to shape various kinds of household products (Setiawati et al. 2017). *B. vulgaris* Schrad. Ex wendl and *G . atter* can be used to build housing, especially livestock sheds, namely cow and chicken coops. Bamboo can also be used as a hatching place for Maleo bird eggs. In addition, bamboo is used to make bridges crossing rice fields or rivers made from this type. The bamboo parts for this building only use medium and slightly old stems (Yanti et al. 2021).

Food Sources

Bamboo shoots are often used as food. Bamboo shoots that can be consumed are bamboo shoots that come from *G. atter* and *B.*

tulda bamboo which are nutritious and widely eaten by ethnic groups in Asia. (Febrianti et al. 2019; Masrilurrahman & Wangiyana, 2022; Putro et al. 2014; Suryani et al. 2019; Waikhom & Louis, 2014).

Traditional Medicine

Bamboo has many chemical compounds, including saponins, flavonoids, polyphenols, tannins, phenolic acids, polysaccharides, and essential oils. The antioxidant and anticancer activities of bamboo extract have been confirmed (Fei et al. 2016). *G. apus* has antihypertensive activity in bamboo shoots (Sunarti & Octaviani 2020) and antidiarrheal activity in leaves (Mulyono et al. 2013) . In *B. vulgaris* var. striata was found to be parahydroxy benzaldehyde, comparable to some groups of silymarin and curcumin which is effective for treating liver problems. Green bamboo stems are used to relieve heartburn and coughs because they contain saponin, aglycone, protocarcapogenin, asparagine, glucose, fructose, 5-methoxy-methylfurfural, and beta-sitosterol (Sulistiono et al. 2016) .

Helps Livelihoods

Bamboo can help fishermen's livelihoods because it can be used as a traditional fishing tool (Hasim et al. 2021). Bamboo is also used as a drying container for Kappaphycus alvarezii seaweed collected from farmers in North Gorontalo (Katili et al. 2019).

Traditional Ceremonies

Bamboo in Gorontalo can be used for incense and skewers. Apart from that, bamboo is used every year, especially during the night by making tumbilotohe (Paneo et al.s 2021). The yellow bamboo (*B. vulgaris* var. striata) or wawahu hulaua is used when holding weddings, death ceremonies, and welcoming great guests. It is rarely found and can replaced with another bamboo which is repainted yellow to make it appear in accordance with the provisions (Sune et al. s2020) . Yellow bamboo itself in Gorontalo society is a special bamboo that is only used on certain occasions. Besides being rare, yellow bamboo is very expensive, so it is only used for special purposes. Yellow bamboo is a symbol of glory, prosperity, and wealth (Husain & Pranata 2023) .

Materials for Crafts

Bamboo has many chemical compounds, Young bamboo stems are often used to make wickerwork. The bamboo that is often used is *Gigantohloa apus*. This bamboo is often used because it is easy to process, does not break easily when bamboo slices are bent, has tenacious fibers and long segments (Sudana & Sumardika, 2020; Jong et al.2018; Sari et al. 2018) .

Bamboo for Ornamental Plants

The bamboo used for ornamental plants is yellow bamboo (*B. vulgaris* var. striata). This bamboo is planted in the front yard of the house as a hedge because it has small stems and leaves and attractive colors (Yanti et al. 2021).

Ecological Functions

Bamboo also has significant environmental benefits. Its roots that grip the soil can help prevent soil erosion and maintain soil stability. Additionally, its roots can leach heavy metals from the soil, and efficiently draw water closer to the surface due to its strong water absorption ability. During its growth, bamboo can also absorb large amounts of nitrogen from the soil and carbon dioxide from the air, which will undoubtedly help reduce water and air pollution problems. (Li & Hes, 2019).

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Figure 1. Morphological characteristics of Gigantochloa apus; a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

Figure 2. Morphological characteristics of Bambusa tulda; a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

Figure 3. Morphological characteristics of Gigantochloa atter a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

Figure 4. Morphological characteristics of Schizostachyum zollingeri; a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

Figure 5. Morphological characteristics of Bambusa tuldoides ; a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

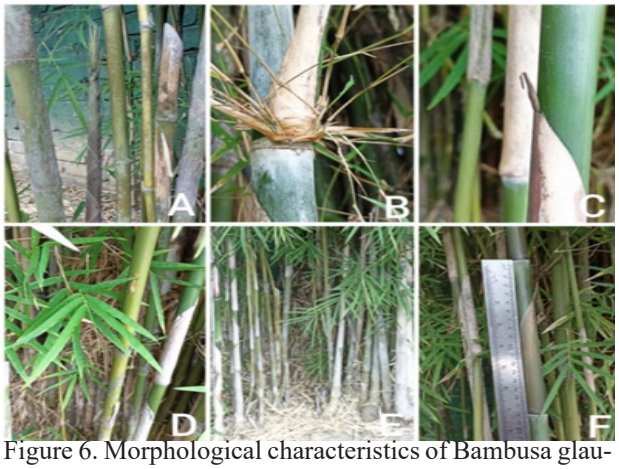

Figure 6. Morphological characteristics of Bambusa glaucophylla ; a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

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Figure 7. Morphological characteristics of Bambusa textilis ; a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

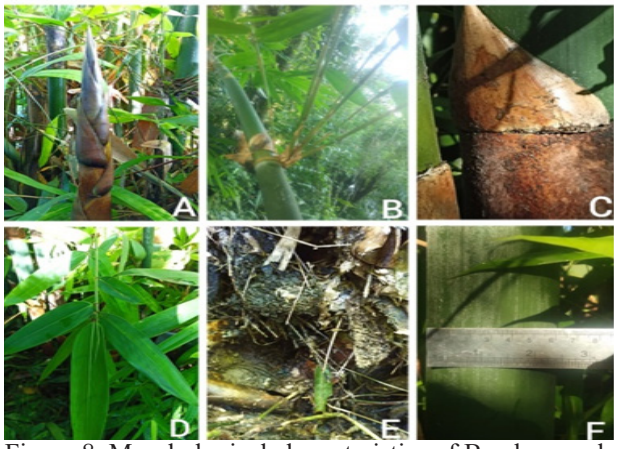

Figure 8. Morphological characteristics of Bambusa vulgaris Schrad. ex JCWendl.; a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

Figure 9. Morphological characteristics of Bambusa vulgaris var striata; a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

Figure 10. Morphological characteristics of Schizostachyum brachycladum; a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

Figure 11. Morphological characteristics of Gigantochloa hasskarliana ; a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

Figure 12. Morphological characteristics of Schizostachyum latifolium ; a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

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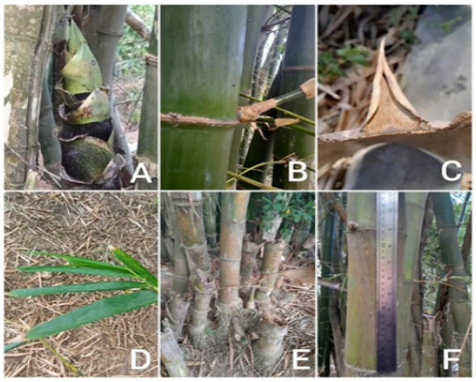

Figure 13. Morphological characteristics of Dendrocalamus asper ; a).Bamboo shoots; b). Branching; c). frond; d). Leaf; e) base of stem; f) stem node.

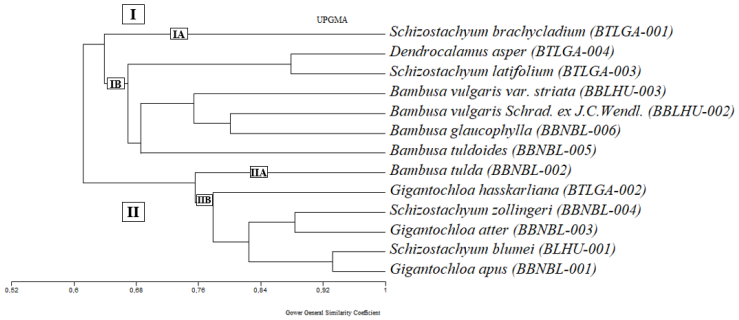

Figure 14. Dendrogram of kinship of 13 bamboo accessions based on morphological characters using the UPGMA method in the MVSP program

CONCLUSION

Gorontalo Province has 13 bamboo species spread across three districts which can be grouped into four genera, namely the Dendrocalamus genus, the Gigantochloa genus, the Bambusa genus, and the Schizostachyum genus. Grouping 13 bamboo accessions in the dendrogram produced a similarity coefficient of 61.2% which formed 2 main clusters which were categorized into minor categories at the species level diversity level. Bamboo plants are widely used as building construction materials, food sources, and traditional medicine, to help people's livelihoods, traditional ceremonies, crafts, ornamental plants, and ecological functions. The results of this research are the first records regarding the identification, morphology and use of bamboo in Gorontalo Province. The data obtained can complete the Gorontalo flora database, supporting the identification and classification of vascular plants. In addition, this information can be a basis for germplasm conservation and plant breeding.

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CONFLICT OF INTEREST

We declare that there is no conflict of interest regarding the publication of this paper.

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