Ethnobotany of bamboo on Weh Island, Aceh, Indonesia

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Research

Abstract

Background: Bamboo plays a vital role in the daily lives of Indonesian people, being utilized across various domains. The majority of research on bamboo ethnobotany has focused on the main islands of Indonesia, neglecting the smaller islands like Weh Island in Aceh, where no information or documentation about bamboo ethnobotany is currently available. This study aimed to examine the ethnobotanical aspects of bamboo on Weh Island.

Methods: The study took place on Weh Island, Aceh, Indonesia, from July to November 2022. Seventy respondents were randomly selected. Data analysis included the use value index (UV), index of cultural significance (ICS), fidelity level (FL), informant consensus factor (ICF), and utilized plant parts.

Results: The local community on Weh Island utilized eight bamboo species (*Bambusa multiplex, B. spinosa, B. tuldoides, B. vulgaris, Dendrocalamus asper, Schizostachyum brachycladum, S. silicatum*, and *Thyrsostachys siamensis*) for various purposes such as ornamental plants, food sources, construction materials, furniture, medicine, handicrafts, animal feed, agriculture construction, traditional toys, and kitchen utensils. The UV and ICS values of bamboo on Weh Island vary between 0.155 (*B. tuldoides*) and 0.918 (*B. vulgaris*) for UV, and from 3 (*B. tuldoides*) to 64 (*B. vulgaris*) for ICS. The FL values vary from 14.81% (*B. spinosa*) to 88.23% (*B. vulgaris*), and the ICF values vary from 0.90 (liver disease) to 1.00 (gastric ulcer, *panas dalam*, lower back pain, hypertension, and asthma). The parts of bamboo utilized on Weh Island include the entire plant (23.53%), from the rhizomes/roots (5.88%), young shoots (11.77%), culms (52.94%), to the leaves (5.88%).

Conclusions: The Weh Island community uses eight bamboo species; *B. vulgaris* is the most useful and important, while *B. tuldoides* is the least. *Bambusa vulgaris* is favoured for treating ailments. Locals consistently view bamboo as a remedy for issues like gout, gastric ulcers, *panas dalam*, lower back pain, hypertension, and asthma. The culm of bamboo is the most utilized part of Weh Island.

Keywords: community knowledge; ethnobotanical; Poaceae; Weh Island

Background

Bamboo (Poaceae, Bambusoideae) is a plant that has a fibrous root system that helps anchor the plant in the soil and absorb water and nutrients. Bamboo has underground stems called rhizomes. They can produce new shoots and culms. Bamboo exhibits a clumping or running growth habit, which depends on its rhizomes. Clumping bamboos tend to grow in tight clumps (mostly in tropical areas) while running bamboos spread through their rhizomes (mostly in temperate areas). Bamboo generally has tall, hollow, and woody surface stems called culms. These culms are commonly cylindrical and are divided into sections by nodes. The internodes are the segments between the nodes, and they can vary in length depending on the bamboo species. Culms are covered with persistent or deciduous culm-sheath. Nodes are the joints or points along the culm where branches, and leaves emerge. Bamboo has long, narrow leaves that are typically lanceolate or linear. Flowering in bamboo is a rare event (Janzen 1976), and it often leads to the death of the plant. However, not all bamboo species flower at the same time or with the same frequency. The fruits of bamboo contain a single seed and are indehiscent, while certain species may have a fleshier, rounded, or pear-shaped appearance (Ritonga *et al.* 2023).

The number of bamboo species in the world is estimated to be over 1500 species (Ahmad *et al*. 2021) or estimated to be between 1439 and 1662 species (Canava *et al.* 2017, Widjaja *et al.* 2014) and approximately 123 genera (Ahmad *et al*. 2021). Indonesia is reported to have 176 species and 25 genera of bamboo (Widjaja 2019). However, it has been corrected that there are actually 175 species and 24 genera of bamboo in Indonesia (Damayanto & Ferirenta 2021). This Indonesian bamboo species will be increased due to some new species that have been published recently (Widjaja 2023, 2020, Muzakki 2020, Ervianti *et al.* 2019). A total of 105 species of Indonesian bamboo are reportedly endemic (Widjaja 2019).

Indonesia is home to a diverse range of bamboo species, with a significant number of endemic species. Hereinafter, bamboo in Indonesia also plays a vital role in the daily lives of the local community, being utilized across various domains. It is estimated that local communities have been using at least 40 species of bamboo in Indonesia. Economically, bamboo can be used in house construction, garden contractions, household furniture, crafts, food sources, musical instruments, traditional ceremony equipment, ornamental plants, kitchen utensils, traditional toys, parts of boats, firewood, fishing rods, umbrella handles, bookshelves, chicken coops, containers for cooking *jaha* or *lemang*, ropes, electricity generation fuel, and medicine (Ihsan *et al.* 2023, Rizqi *et al.* 2023, Sejati 2023, Riswan *et al.* 2022, Sitepu 2022, Cahyanto 2021, Kuncari & Setiawan 2021, Hadjar *et al*. 2020, Ritonga *et al*. 2020a, Irawan *et al.* 2019, Jannah *et al.* 2019, Riastuti *et al*. 2019, Tang *et al.* 2019, Widjaja 2019, Jong *et al.* 2018, Nasution 2018, Sujarwo 2018, Yani & Anggraini 2018, Sulistiono *et al.* 2016, Nurdianti & Putro *et al.* 2014, Munziri *et al*. 2013, Mayasari & Suryawan 2012, Sujarwo *et al.* 2010).

The diverse species of bamboo found in Indonesia, including many endemic species, contribute to its rich economic potential and ethnobotany knowledge. Ethnobotany is important for understanding the cultural context of plant use, discovering new medicines, conserving traditional knowledge, and understanding the relationships between humans and plants. It has practical implications for sustainable agriculture and offers insights into the diverse ways in which plants are utilized by different cultures. However, the majority of research on bamboo ethnobotany in Indonesia has focused on the main island areas (*see* Ihsan *et al.* 2023, Riswan *et al.* 2022, Kuncari & Setiawan 2021, Irawan *et al.* 2019, Tang *et al.* 2019, Jong *et al.* 2018, Nasution 2018, Sujarwo 2018, Yani & Anggraini 2018), neglecting the smaller islands like Weh Island in Aceh, Sumatra, where no information or documentation about bamboo ethnobotany is currently available. The local community of Weh Island is Acehnese who is thought to have good knowledge of utilizing plants, especially bamboo. This study aimed to examine the ethnobotanical aspects of bamboo on Weh Island. An investigation was conducted to find out how bamboo was used by the people of Weh Island to preserve traditional knowledge.

Materials and Methods

Study area

Geographically, Weh Island (also known as Sabang Island) is located at the westernmost tip of Sumatra Island in Indonesia. It has a land area of 120.7 km^2 (Pemerintah Kota Sabang 2023). The island is situated at coordinates 95°13'02"-95°22'36" E and 05°46'28"-05°54'28" N (Badan Pusat Statistik Kota Sabang 2020). The elevation of the island ranges from 0 to 213 meters above sea level. This small island was formed due to volcanic activity, resulting in its separation from the mainland of Sumatra (Edyanto 2008). Administratively, Weh Island is part of the cluster of islands owned by Kota Sabang, Aceh Province, Indonesia. The local ethnic group of Weh Island is Acehnese. Data were collected from several villages on Weh Island, including Anoe Itam, Balohan, Cot Abeuk, Cot Ba'u, Jaboi, Ujong Kareung, Aneuk Laot, Batee Shoek, Iboih, Kuta Ateueh, Kuta Timu, Paya, and Paya Seunara (Fig. 1).

The average temperature in Weh Island (Kota Sabang) in December 2022 was 26°C, with an average humidity of 87%. The total rainfall for December 2022 was 401.4 mm, with 23 rainy days and an average sunshine duration of 2.8 hours (Badan Pusat Statistik Kota Sabang 2023). The economy of the island is dominated by agriculture, with the main products being cloves and coconuts. In the livestock sector, free-range chicken farming is prominent, goats and fisheries are also notable. The education situation of the Island can be assessed through the net enrolment rate (NER). The NER value can depict the educational system's absorption capacity for the school-aged population. In 2022, the NER values in Weh Island (Kota Sabang) for elementary and junior high school levels were quite high, at 99.90 and 94.02 respectively. Meanwhile, the NER value for senior high school in the same year was 78.86 (Badan Pusat Statistik Kota Sabang 2023). The total number of general hospitals in Weh Island (Kota Sabang) is 1 unit, there are 4 units of inpatient public health centres and 2 units of non-inpatient public health centres (Badan Pusat Statistik Kota Sabang 2023).

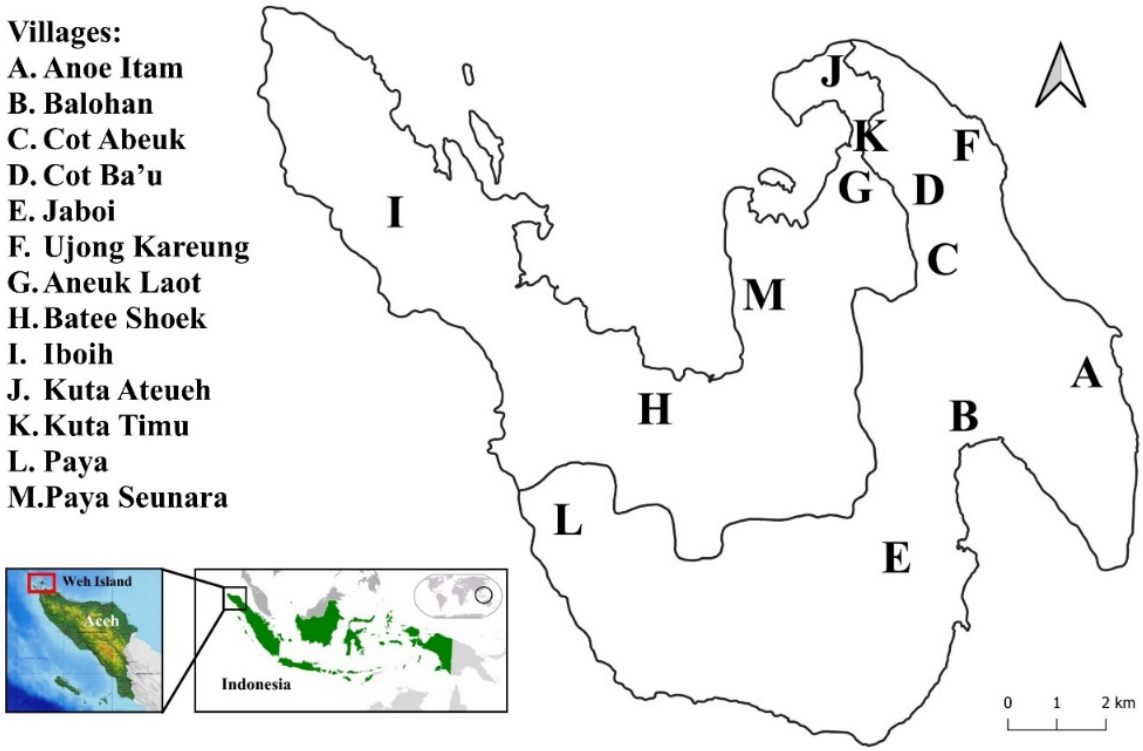

Figure 1. Map of the study area with the data collection sites in Weh Island

Data collection

An ethnobotanical survey was conducted from July to November 2022. The sample size was calculated using the Cochran sample size formula (Bartlett *et al.* 2001). A total of 70 respondents were randomly selected (Table 1), with 71% of them being male and the remaining 29% being female (Fig. 2A). The majority (54%) of the respondents were aged between 41 and 50 years old (Fig. 2B), and the largest proportion (36%) had completed Elementary School (Fig. 2C). All participants belonged to the Acehnese ethnic group. The primary occupation of the residents of Weh Island is agriculture (farmers), which holds significant importance in their lives. In addition to farming, fishing (fishers) is another prevalent activity, predominantly undertaken by men. Women, on the other hand, typically engage in the role of homemakers (Fig. 2D).

Table 1. Demographic status of informants of Weh Island

Characteristics	Study area (villages)												
	AI	BI	CA	CB	Jb	UK	AL	BS	Io	KA	KT	Py	PS
Gender													
Male	7	8	6	0	4	3	7	6	1	3	1	2	2
Female	4	7	0	3	0	0	6	0	0	0	0	0	0
Age (years old)													
30–40	1	2	0	0	0	0	0	2	0	1	0	0	0
41–50	8	10	5	2	3	2	1	4	1	1	0	0	1
51–60	1	2	1	1	1	1	12	0	0	1	0	2	1

61–70	1	1	0	0	0	0	0	0	0	0	1	0	0
Level of education													
Elementary School	1	8	0	0	2	0	10	1	0	1	1	0	1
Junior High School	3	1	4	3	1	1	1	4	1	1	0	1	0
Senior High School	6	5	1	0	1	2	1	1	0	1	0	1	1
Bachelor Degree	1	2	1	0	0	0	0	0	0	0	0	0	0

AI = Anoe Itam, Bl = Balohan, CA = Cot Abeuk, CB = Cot Ba'u, Jb = Jaboi, UK = Ujong Kareung, AL = Anuek Laot, BS = Batee Shoek, Io = Iboih, KA = Kuta Ateueh, KT = Kuta Timu, Py = Paya, PS = Paya Seunara

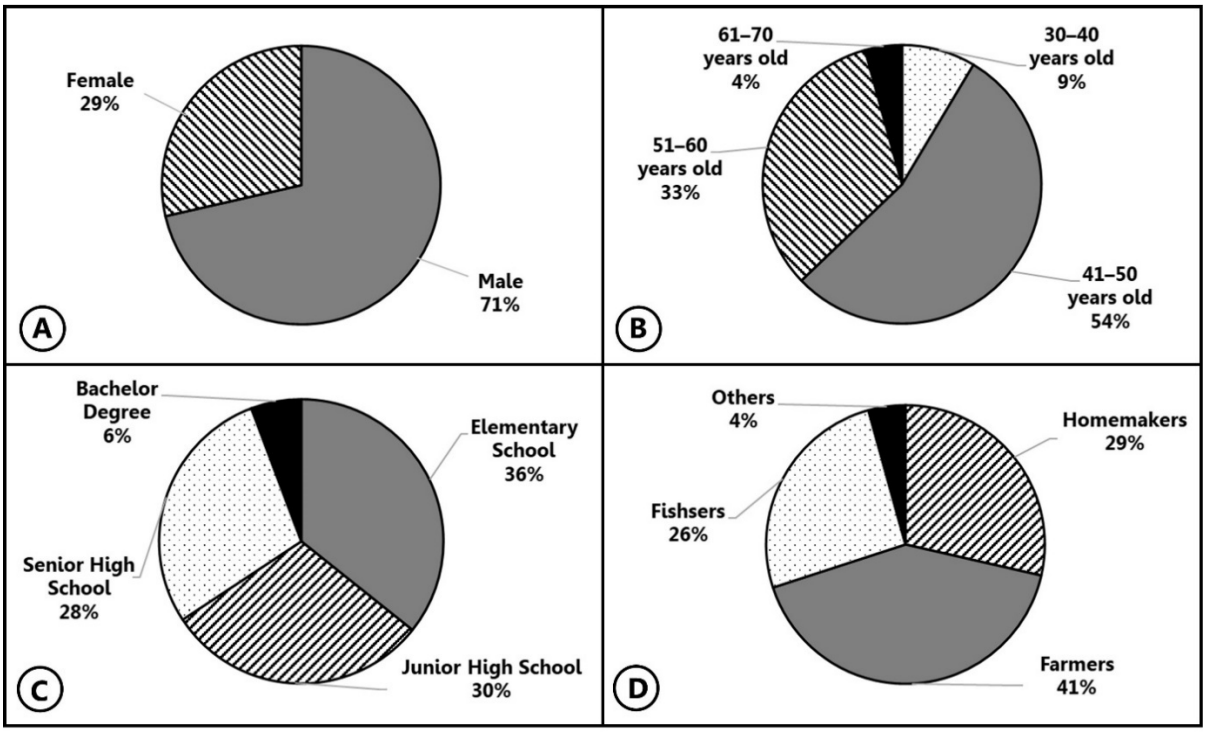

Figure 2. Profile of informants of Weh Island: A. gender ratio, B. age status, C. education level, D. occupations

Herbarium collection

Bamboo samples were collected following the methodology described by Rugayah *et al.* (2004). These samples were then sent to the Herbarium Andalas (ANDA) and Herbarium Bogoriense (BO) for further processing, as outlined in Djarwaningsih *et al.* (2002), to create herbarium specimens. Before identification, the bamboo materials underwent a drying process. The identification process involved referring to the herbarium specimens at ANDA and BO, as well as relevant literature. The identified herbarium specimens were subsequently stored at ANDA and BO. The accepted species names were determined based on the references Widjaja and Wong (2016), Wong and Dransfield (2016), Vorontsova *et al*. (2016), and online sources such as the International Plant Names Index (https://ipni.org) or the Plants of the World Online (https://powo.science.kew.org) (Damayanto *et al.* 2020a). Herbarium abbreviation followed Index Herbariorum of New York Botanical Garden Steere Herbarium (Thiers 2023).

Data analysis

The assessment of the local importance value of each bamboo species was conducted using various ethnobotanical indices, namely (1) the use value index (UV); (2) the index of cultural significance (ICS); (3) fidelity level (FL); (4) informant consensus factor (ICF); and (5) the plant parts used. The UV represents the diversity of uses for each plant species. This UV is evaluated using the formula mentioned by Zenderland *et al.* (2019) (Formula 1).

$$UV = \Sigma U/N \qquad \text{(Formula 1)}$$

where: UV is the Use Value Index, U is the total number of uses mentioned by informants for a plant species, and N is the total number of informants interviewed for that plant species.

The ICS measures the significance of each plant species by considering its quality value, intensity value, and exclusivity value. This ICS is evaluated using the formula mentioned by Turner (1988) (Formula 2).

$$\sum_{i}^{n} = 1\ (q \times i \times e)\ ni \qquad \text{(Formula 2)}$$

where: q represents the quality value, which is the total use of a plant species, i represents the intensity value, which measures the intensity of utilization of a plant species, and e represents the exclusivity value, which indicates the level of exclusivity or preference for a plant species.

The FL is useful for identifying the most preferred plants used for treating specific diseases by respondents. This FL is evaluated using the formula mentioned by Andriamparany *et al.* (2014) (Formula 3).

$$FL\ (\%) = (Np/N) \times 100 \qquad \text{(Formula 3)}$$

where: Np represents the number of respondents reporting the utilization of a medicinal plant for a specific disease, and N represents the total number of respondents mentioning the same plant for each disease.

The ICF is calculated for each disease category to identify the community consensus regarding plant species used to treat specific illnesses. This ICF is evaluated using the formula mentioned by Tariq *et al.* (2014) (Formula 4).

$$ICF = (Nur\text{-}Nt)/(Nur\text{-}1) \qquad \text{(Formula 4)}$$

where: Nur is the number of uses of plant species for each disease category. Nt is the total number of taxa used for a specific category by all respondents.

Principal Component Analysis (PCA) was conducted using the online software Statistics Kingdom (2023) to assist in identifying patterns and correlations in bamboo utilization.

Results

A total of eight bamboo species (*Bambusa multiplex, B. spinosa, B. tuldoides, B. vulgaris, Dendrocalamus asper, Schizostachyum brachycladum, S. silicatum*, and *Thyrsostachys siamensis*) were found on Weh Island (Fig. 3), all of which are utilized by the local communities (Table 2). Generally, bamboo on Weh Island is used for various purposes, including ornamental plants, vegetables, construction materials, furniture, medicinal ingredients, handicrafts, animal feed, agricultural construction materials, traditional toys, and kitchen utensils (Fig. 4).

The UV and ICS values of bamboo on Weh Island varies between 0.064 and 0.918 for UV, and from 3 to 64 for ICS, as indicated in Table 2. The FL value varies from 14.81% to 88.23% (Table 3) and the ICF value vary from 0.90 to 1.00 (Table 4). The parts of bamboo utilized on Weh Island include the entire plant, from the rhizomes/roots, young shoots, and culms to the leaves (Table 5). The biplot of the principal component analysis (Fig. 5) showed the clustering of bamboo utilization among 8 bamboo species. There are 4 clusters of bamboo species based on their utilization along the first to fourth ordination axes (Fig. 5).

Figure 3. Bamboo species on Weh Island: A. *Bambusa multiplex,* B. *Bambusa spinosa*, C. *Bambusa tuldoides,* D. *Bambusa vulgaris* 'green culm', E. *Bambusa vulgaris* 'yellow culm', F. *Dendrocalamus asper,* G. *Schizostachyum brachycladum,* H. *Schizostachyum silicatum*, and I. *Thyrsostachys siamensis*. Photos: Muhammad Azli Ritonga

Table 2. Traditional uses of local bamboo species by communities on Weh Island

Scientific name (collection no. and herbaria)	Local name	Habitat	Plant part used	Uses	Villages	UV	ICS
Bambusa multiplex (Lour.) Raeusch. ex Schult.f. MAR 073 (ANDA; BO)	**Igeuh kawe**	Settlements on the edge of the market	All parts	Planted as a fence or boundary, culms are used as fishing rod, and toy (guns)	KA	0.254	12
Bambusa spinosa Roxb. MAR 038, 042, 054 (ANDA; BO)	**Trieng duroe**	Riverbanks and near settlements	Culms	Culms are used as poles, coarse baskets as containers for coconuts, wastebaskets, ladders, furniture, clapper, chicken coops, and to cure gout and liver disease	Bl, Jb	0.821	60
Bambusa tuldoides Munro MAR 075 (ANDA; BO)	**Trieng biasa**	Along the main road, near the market, and near the settlements	All parts	Planted as a fence or boundary and to cure *panas dalam*	KA	0.155	3
Bambusa vulgaris Schrad. ex J.C.Wendl. MAR 039, 045, 052, 055, 056, 057, 059, 064, 067, 068, 069, 070, 074, 076, 079, 082 (ANDA; BO)	**Trieng kuneng**	Riverbanks, near the settlements, along the road, and the plantations	All parts	Culms of green varieties are used for making fences and young shoots are used for vegetables. Yellow varieties are used for treating gout and as ornamental plants, and to cure gastric ulcer, fever, and liver disease	Bl, UK, CB, AI, BS, Py, PS, AL, KA	0.918	64
Dendrocalamus asper (Schult. & Schult.f.) Backer MAR 060, 081 (ANDA; BO)	**Trieng betung**	Along the road, riverbanks, and settlements	Young shoots and culms	Culms are used for making baskets for storing bananas, as construction materials, as cannon toys, and the shoots are used as vegetables, and to cure hypertension and fever	BS, AL	0.516	52
Schizostachyum brachycladum (Kurz ex Munro) Kurz MAR 040, 063, 071 (ANDA; BO)	**Buloh leumang**	Riverbanks, backyard, along the road, and settlements	Culms	Culms are used as containers in the making of *lemang*, and to cure lower back pain	Bl, KT, BS.	0.216	12
Schizostachyum silicatum Widjaja MAR 037, 047, 053, 062, 065, 077, 078, 080, 083 (ANDA; BO)	**Igeuh**	Forest and along the road	Culms and leaves	Culms are used as stakes for chilli plants, as fencing and the leaves are used as fodder for cattle, and to cure asthma	Bl, AI, BS	0.604	39
Thyrsostachys siamensis Gamble	**Trieng pageue**	Along the road, riverbanks, forests,	All parts	Planted as an ornamental plant or barrier, and culms are used as poles	Bl, Jb, CA, CB, UK,	0.604	21

Scientific name (collection no. and herbaria)	Local name	Habitat	Plant part used	Uses	Villages	UV	ICS
MAR 041, 043, 044, 046, 048, 049, 050, 051, 058, 061, 066 (ANDA; BO), 072 (ANDA)		plantations, and near settlements			BS, Py, Io, KA		

AI = Anoe Itam, Bl = Balohan, CA = Cot Abeuk, CB = Cot Ba'u, Jb = Jaboi, UK = Ujong Kareung, AL = Anuek Laot, BS = Batee Shoek, Io = Iboih, KA = Kuta Ateueh, KT = Kuta Timu, Py = Paya, PS = Paya Seunara

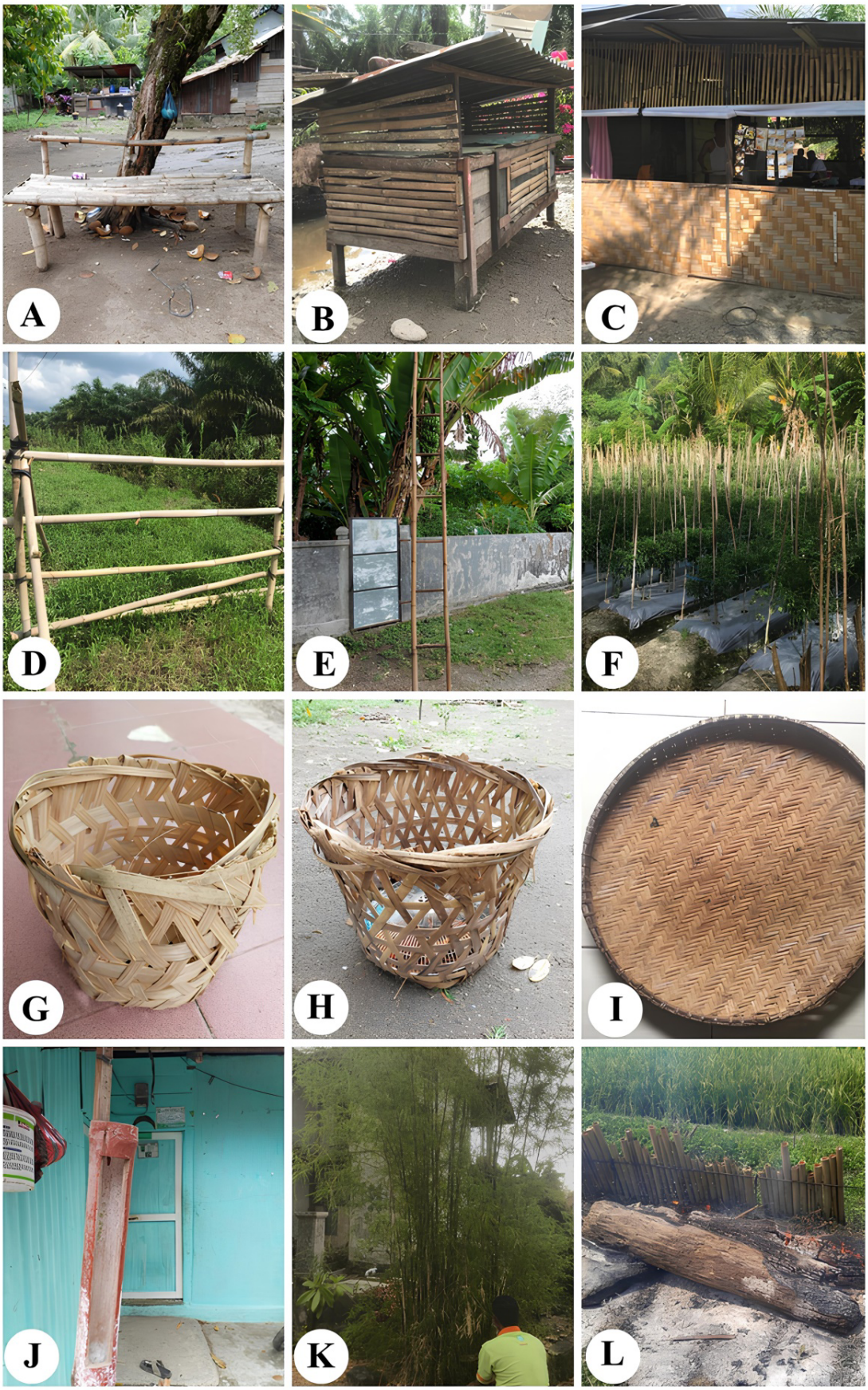

Figure 4. Several uses of bamboo on Weh Island: A. chair, B. henhouse, C. wall webbing (*gedek*), D. fences, E. ladder, F. stakes to support the chili plants, G. baskets for fruit containers, H. wastebasket, I. tray, J. clapper (*kentungan*), K. ornamental plants, and L. containers in the making of *lemang*. Photos: Muhammad Azli Ritonga

Table 3. Fidelity level (FL) values of bamboo species used as medicine on Weh Island

Diseases	Fidelity level (FL) of bamboo species
Gout	*Bambusa spinosa* (37.31%); *Bambusa vulgaris* (88.23%)
Gastric ulcer	*Bambusa vulgaris* (36.66%)
Panas dalam	*Bambusa tuldoides* (31.37%)
Lower back pain	*Schizostachyum brachycladum* (30.76%)
Hypertension	*Dendrocalamus asper* (58.69%)
Asthma	*Schizostachyum silicatum* (28.57%)
Fever	*Bambusa vulgaris* (43.90%); *Dendrocalamus asper* (43.33%)
Liver disease	*Bambusa vulgaris* (68.18%); *Bambusa spinosa* (14.81%)

Table 4. Diseases and informant consensus factor (ICF)

Diseases	Number of uses	Number of bamboo species used	ICF
Gastric ulcer	21	1	1.00
Panas dalam	16	1	1.00
Lower back pain	13	1	1.00
Hypertension	18	1	1.00
Asthma	7	1	1.00
Gout	32	2	0.97
Fever	16	2	0.93
Liver disease	11	2	0.90

Table 5. Number of bamboo species and the corresponding percentage of plant parts utilized by the local community on Weh Island

Plant parts used	Number of species	Percentage (%)
Rhizomes/root	1	5.88
Young shoots	2	11.77
Culms	9	52.94
Leaves	1	5.88
Entire part	4	23.53
Total	**17**	**100**

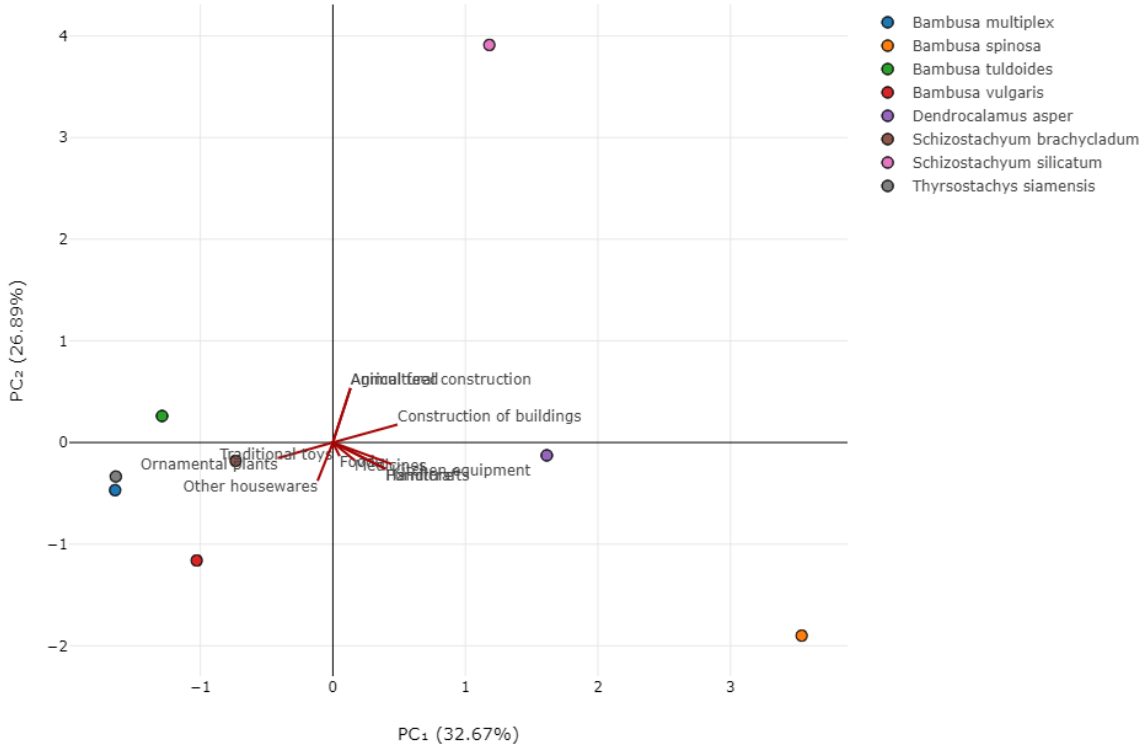

Figure 5. Biplot of principal component analysis of bamboo utilization in Weh Island

Discussion

In Weh Island, *B. vulgaris* stands out as the most plentiful bamboo species. This bamboo is widely distributed around the island. On the other hand, *B. multiplex* and *B. tuldoides* are comparatively less present on Weh Island. Based on Table 2, *B. vulgaris* has the highest UV (0.918) and ICS (64) values, while *B. tuldoides* has the lowest UV (0.155) and ICS (3) values. The UV index can identify plants that offer the greatest benefits to specific community groups (Albuquerque *et al*. 2006). The significant use value of a particular bamboo species serves as evidence of its crucial role in supporting the livelihoods of local communities. The importance value of a plant increases as the demand for its utilization grows (Maulidah 2015). From the information provided, it can be inferred that *B. vulgaris*, with a UV value of 0.918, offers the most significant advantages to the community of Weh Island.

Bambusa vulgaris is widely distributed on Weh Island and is the most abundant bamboo species. Therefore, it is not surprising that the people of Weh Island are very familiar with this bamboo and utilize it in their daily lives. Communities in diverse regions are known to utilize *B. vulgaris* for a variety of purposes, such as medicine, vegetable ingredients, fencing, building materials, plant support sticks, decorations, kitchen utensils, furniture, mats, ashtrays, food containers, ornamental plants, and erosion control plants (Sholihah *et al.* 2022, Mutmainah *et al.* 2021, Siskawati 2021, Damayanto & Rahmawati 2020, Ervany *et al.* 2020, Retnawati *et al.* 2020, Ritonga *et al.* 2020b, Sujarwanta & Zen 2020a, 2020b, Liana *et al.* 2017a, 2017b, Muhtar *et al.* 2017, Ekayanti 2016, Yani 2014, Sujarwo *et al.* 2010, Widjaja 2001b, Dransfield & Widjaja 1995a,). The abundant of *B. vulgaris* on Weh Island, and even in Indonesia, is believed to be due to its high tolerance to environmental changes, such as being able to grow in waterlogged areas for several months (Damayanto *et al.* 2019, Damayanto 2018a, Widjaja 2001a).

Furthermore, *B. spinosa* also shows a significant UV value of 0.821, following *B. vulgaris* (Table 2). This signifies that *B. spinosa* also benefits the community of Weh Island. Reports indicate that *B. spinosa* grows wild in specific areas (Damayanto & Fefirenta 2021, Damayanto *et al.* 2020b) or is cultivated near settlements (Robiah *et al.* 2022). All *B. spinosa* on Weh Island are found in proximity to residential areas. Similar to *B. vulgaris*, despite its irregular and thorny culms, communities still use this bamboo daily due to its proximity to residential areas on Weh Island. In other regions, *B. spinosa* is utilized for various purposes, including fencing, house construction, windows materials, chairs, plant supports, coarse baskets, chicken coops, and roofing materials (Ritonga *et al.* 2020a, Sujarwanta & Zen 2020b, Lemburosa & Ratnaningsih 2018, Muhtar *et al.* 2017).

On the other hand, *S. silicatum* and *T. siamensis* have a UV value of 0.604, slightly lower than *B. vulgaris* and *B. spinosa* (Table 2). The straight and long internode culms of *S. silicatum* are often used as stakes for chilli plants and as fencing on Weh Island. Meanwhile, the dense culms of *T. siamensis* are commonly utilized as fences. These morphological characteristics are unique to these bamboo species and not found in several other bamboo species on Weh Island. Hence, both of these bamboo species are still extensively utilized on Weh Island. In other regions, these bamboo species are reportedly used as ornamental plants, boundary fences, windbreaks, kitchen tools, hats materials, and vegetables (Damayanto 2018b, Ekayanti 2016, Munziri *et al.* 2013, Widjaja 2001b, Sastrapradja *et al.* 1977, Duriyaprapan & Jansen 1995).

The UV value of *D. asper* (0.516) is not as high as the values of *B. spinosa*, *B. vulgaris*, *S. silicatum*, and *T. siamensis* (Table 2). In fact, *D. asper* is widely recognized for its high and diverse benefits. For instance, in other regions, *D. asper* is utilized in animal pens, fencing, poles, water pipes, building materials, furniture, construction, house walls, bridges, vegetables, and for hypertension treatment (Febrianti *et al.* 2022, Sholihah *et al.* 2022, Ritonga *et al.* 2020a, Riastuti *et al.* 2019, Liana *et al.* 2017b, Yani & Anggraini 2018). Nevertheless, due to the relatively limited presence of *D. asper* on Weh Island, the local community is not well acquainted with its utilization, resulting in a relatively low benefit value on the island.

Bambusa multiplex, *B. tuldoides*, and *S. brachycladum* are bamboo species with the lowest UV values (0.254, 0.155, 0.216 respectively) on Weh Island (Table 2), indicating that these species are utilized less frequently. *Bambusa multiplex* and *B. tuldoides* are introduced species (Ritonga *et al.* 2020b; Widjaja 2019), which explains their limited recognition and utilization. In other regions, these bamboo species are primarily reported to be used as ornamental plants (Sari *et al.* 2021, Damayanto & Rahmawati 2020, Ritonga *et al.* 2020a, Munziri *et al.* 2013). Apart from being lesser-known introduced species, the infrequent presence of *B. multiplex* and *B. tuldoides* on Weh Island also contributes to their lower UV values compared to other well-known and cultivated bamboo species. On the other hand, *S. brachycladum* is typically known for its diverse uses, such as roofing material, food wrappers, erosion control, firewood, construction material, ceremonial purposes, and weaving material (Sujarwanta & Zen 2020b, Ekayanti 2016, Munziri *et al.* 2013). However, *S. brachycladum* is not extensively utilized on Weh Island, except for its ornamental value, as it is rarely cultivated on a large scale.

According to Table 2, there are three bamboo species with high cultural significance values (ICS): *B. vulgaris* (64), *B. spinosa* (60), and *D. asper* (52). One species, *S. silicatum*, falls under the moderate category with an ICS value of 39. Four other species, *B. multiplex* (12), *B. tuldoides* (3), *S. brachycladum* (12), and *T. siamensis* (21), have low ICS values. ICS indicates the level of importance of each plant species to a particular ethnic group (Hoffman & Gallaher 2007). Turner (1988) states that the higher value of a plant's usefulness, the greater its importance value. The high category of ICS indicates that *B. vulgaris*, *B. spinosa*, and *D. asper* play significant roles in the daily lives of the community on Pulau Weh. Bamboo is presumed to be an integral part of the cultural life of the Acehnese on Weh Island, as it cannot be overlooked.

On Weh Island, bamboo plays an important role in the lives of the community, such as in handicrafts and kitchen utensils. Initially, the bamboo clapper (known as *kentungan* in Indonesia) made from *B. spinosa* was used as a companion tool for patrolling to alert against thieves or natural disasters on Weh Island. The bamboo clapper was used to quickly gather information about ongoing events, eliminating the need for relying solely on word-of-mouth announcements. However, the bamboo clapper has transformed its function. Farmers now utilize it as a tool to scare away animals that damage plants.

The knowledge of the Weh Island community regarding the utilization of *B. vulgaris*, *B. spinosa*, and *D. asper* is relatively high, compared to their knowledge about the utilization of *B. multiplex*, *B. tuldoides*, *S. brachycladum*, and *T. siamensis*, which have low ICS values. It is suspected that the presence of *B. vulgaris*, *B. spinosa*, and *D. asper* on Weh Island has been known much earlier than the spread of *B. multiplex*, *B. tuldoides*, *S. brachycladum*, and *T. siamensis* there. This is supported by the fact that *B. multiplex*, *B. tuldoides*, and *T. siamensis* are introduced species (Ritonga *et al.* 2020b, Widjaja 2019, Duriyaprapan & Jansen 1995) which might not be well-known by the people of Weh Island. Additionally, those species are generally known for their use as ornamental plants (Sari *et al.* 2021, Damayanto & Rahmawati 2020, Ritonga *et al.* 2020a, Munziri *et al.* 2013), resulting in sometimes suboptimal utilization for other purposes.

On the other hand, *S. silicatum* has a moderate level of ICS value. This species is reported to be native and distributed in Sumatra, Java, and Bali (Widjaja 2019). Thus, the utilization of this species has been known by the Indonesian community for a long time, including the community on Weh Island, especially considering the abundant presence of this bamboo species on the island. However, *S. silicatum* has relatively thin culms (Widjaja 1997), making it less suitable for applications that require strong culms, such as pillars or structural supports. *Schizostachyum* species are typically excellent for weaving and

handicrafts (Tika *et al.* 2020, Munziri *et al.* 2013), although not all ethnic groups in Indonesia have the culture of bamboo weaving or using bamboo for handicrafts (Prasaja *et al.* 2015, Hidayat *et al.* 2010).

The fidelity level (FL) is used to determine which bamboo species are most commonly utilized as medicine. Plant species that are widely used as medicine have higher FL values compared to less popular plant species (Alexiades & Sheldon 1996). Khan *et al.* (2014) stated that FL values indicate the percentage of informants utilizing a plant species for the same primary purpose. There are six bamboo species (*B. spinosa*, *B. vulgaris*, *B. tuldoides*, *D. asper*, *S. brachycladum*, and *S. silicatum*) used as medicine by the Acehnese ethnic group on Weh Island with varying FL values (Table 3). Diseases believed by the Acehense to be controllable through the utilization of bamboo comprise gout, gastric ulcer, *panas dalam*, lower back pain, hypertension, asthma, fever, and liver disease. The term "*panas dalam*" is actually not recognized in the medical world. This condition is also not really a disease, but rather a collection of symptoms from throat-related issues or early symptoms of viral or bacterial infections.

Based on Table 3, *B. vulgaris* has the highest FL value (68.18%) for liver disease, while *B. spinosa* has the lowest FL value (14.81%) for liver disease. This indicates that *B. vulgaris* is the most popular bamboo species used for liver treatment compared to *B. spinosa* or other bamboo. Sujarwanta & Zen (2020b) stated that *B. vulgaris*, especially the yellow culm variant, contains active compounds with potential as a remedy for liver disease (*hepatitis*). Anghore & Kulkarni (2016) tested the active compound content of the leaf extract of *B. vulgaris* yellow culm variant on the liver of experimental rats, and they concluded that *B. vulgaris* holds the potential to serve as a safe and effective alternative treatment in the future for addressing hepatic conditions. Other diseases believed to be curable using bamboo concoctions, such as gout, gastric ulcer, *panas dalam*, lower back pain, hypertension, asthma, and fever, need further scientific study.

To ascertain the uniformity of information among various informants concerning specific disease categories in the research region, the ICF analysis is employed (Trotter *et al.* 1986). As per Gazzaneo *et al.* (2005), a low ICF value (approaching zero) indicates that informants aren't exchanging information about the plant's traditional medicinal use. Conversely, the value will be elevated (nearing one) if there are clearly defined selection criteria within the community and/or if informants share information. It can be inferred that the ICF value reflects the degree of consensus in information among the informants included in the study. Based on the ICF analysis (Table 4), out of 8 types of diseases, 5 types of diseases exhibit high information homogeneity or consensus (ICF = 1.00), namely: gastric ulcer, *panas dalam*, lower back pain, hypertension, and asthma. The least level of homogeneity is fever (0.93) followed by gout (0.97) and liver disease (0.90). Based on this data, the people of Weh Island have consistent information regarding the utilization of bamboo as a remedy for diseases such as gastric ulcer, *panas dalam*, lower back pain, hypertension, and asthma.

The processing of bamboo as medicine by the people of Weh Island is typically carried out in a fairly simple manner. Generally, simple traditional methods such as boiling, grinding, or consuming it directly are commonly used. The most widely utilized method of processing medicinal bamboo among the community of Weh Island is through boiling, followed by grinding and then applying it topically. About 62.5% of the community chooses to consume the boiled bamboo infusion, while the remaining 37.5% apply it to their skin.

The parts of bamboo utilized on Weh Island include the entire plant, from the rhizomes/roots, young shoots, culms, to the leaves. According to Table 5, the culms are the most widely utilized part of bamboo on Weh Island (52.94%). Culms have the highest potential for utilization compared to other parts of bamboo because they are flexible yet strong and have long been known as a wood substitute (Wulandari *et al.* 2021, Sujarwanta & Zen 2020b). Due to the properties of culms, they are often used as construction materials, weaving materials for crafts, support tools (stakes), furniture, musical instruments, toys, poles, handles for objects, containers, and various other purposes (Damayanto & Rahmawati 2020, Ritonga *et al.* 2020a, Doni *et al.* 2018, Liana *et al.* 2017a, 2017b, Muhtar *et al.* 2017, Yani 2014, Artiningsih 2012, Widjaja 2001b, Dransfield & Widjaja 1995b, Roxas 1995). The easy and simple processing methods also contribute to the popularity of bamboo culms for various household products (Siskawati & Sukenti 2021, Ritonga *et al.* 2020a, Sujarwanta & Zen 2020b, Putro *et al.* 2014).

The bamboo parts that are least utilized by the people of Weh Island are the rhizomes/roots and leaves (both 5.88%). In other areas, bamboo leaves can be used for food wrapping and medicinal purposes (Darwanto *et al.* 2022, Sari *et al*. 2019). On the other hand, bamboo rhizomes/roots have been widely utilized in other regions for crafting, such as making duck ornaments or other art crafts (Merdikawati *et al.* 2017). However, the use of bamboo leaves and rhizomes/roots is often closely tied to local culture, and not all regions know utilizing these parts of bamboo. The lack of cultural practices in utilizing bamboo leaves and rhizomes/roots on Weh Island is believed to be the reason for their low utilization in daily life.

The biplot of the principal component analysis (Fig. 5) showed the clustering of bamboo utilization among 8 bamboo species. For example, PC1 (32.67%) and PC2 (26.89%) represent the species distribution in the biplot. In this biplot, *Bambusa multiplex*, *B. vulgaris*, *S. brachycladum*, and *T. siamensis* are grouped on the first ordination axis. *B. tuldoides* stands alone in a group on the second ordination axis, while *S. silicatum* also stands alone in a group on the third ordination axis. *Bambusa spinosa* and *D. asper* are grouped on the fourth ordination axis. Therefore, there are 4 clusters of bamboo species based on their utilization along the first to fourth ordination axes. Together, these axes explain 59.55% of the variance in the dataset. The first ordination axis separates a cluster mostly associated with ornamental plants and housewares, while the third ordination axis separates a cluster mostly associated with the construction of buildings and agricultural constructions, and the fourth ordination axis separates a cluster mostly associated with kitchen equipment and handicrafts.

As we conducted our research on Weh Island, we gained an understanding of the traditional stories and cultural beliefs associated with bamboo. The people of Weh Island hold a belief known as 'the bamboo ghost', which involves a superstition regarding cutting bamboo in the afternoon and evening. According to the community of Weh Island, engaging in bamboo cutting during these times may attract supernatural beings to follow individuals, leading to potential illness, particularly fever, and the risk of being kidnapped by these entities. The belief is rooted in the assumption that afternoons and evenings are meant for rest and leisure at home. In other regions, such as Penglipuran Village, Bangli, Bali, bamboo harvesting is not allowed on Sundays or during the days of '*Ingkel Buku*' and '*Kajeng Umanis*' (days in the traditional Balinese calendar) (Sendratari & Margi 2019). If the rule is broken, there is a belief that the harvested bamboo will die. According to the understanding of the Penglipuran Village community, during those specific days, bamboo plants were believed to be 'imbued with a soul' by the deities, and hence, they should not be disturbed. Essentially, this prohibition stems from traditional wisdom aiming to prevent humans from haphazardly cutting bamboo, considering the significant amount of time needed to restore its original state (Sendratari & Margi 2019). Concerns about the potential extinction of bamboo have contributed to the widespread adoption of this belief, making it a significant aspect of daily life within the Weh Island and Penglipuran Village communities.

In the end, this research highlights the cultural significance of bamboo, with *B. vulgaris*, *B. spinosa*, and *D. asper* holding high values, integral to the daily lives of the Acehnese on Weh Island. Several bamboo species, including *B. vulgaris* and *B. spinosa*, are employed, particularly with *B. vulgaris* noted for its popularity in treating disease. This research significantly contributes to understanding the multifaceted roles of bamboo on Weh Island, fostering insights into the intricate relationships between local communities and bamboo resources.

Conclusion

The local community on Weh Island utilized eight bamboo species (*Bambusa multiplex, B. spinosa, B. tuldoides, B. vulgaris, Dendrocalamus asper, Schizostachyum brachycladum, S. silicatum*, and *Thyrsostachys siamensis*) for various purposes such as ornamental plants, food sources, construction materials, furniture, medicine, handicrafts, animal feed, agriculture construction, traditional toys, and kitchen utensils. *Bambusa vulgaris* is the most useful and important. *Bambusa tuldoides* is considered the least useful and important. *Bambusa vulgaris* is the most preferred plant used for treating specific diseases. The people of Weh Island have consistent information regarding the utilization of bamboo as a remedy for diseases such as gastric ulcers, *panas dalam*, lower back pain, hypertension, and asthma. Bamboo culms are the most frequently used on Weh Island.

Declarations

List of abbreviations: ANDA = Herbarium Andalas; BO = Herbarium Bogoriense; ICS = index of cultural significance; ICF = informant consensus factor; FL = fidelity level; UV = use value index.

Ethics approval and consent to participate: All study participants and informants of Acehnese of Weh Island were briefed about the objectives of the present study. All of them rendered oral consent to share the information.

Consent for publication: The manuscript does not contain any individual person's data in any form. All authors have read and given their approval for the publication of the final manuscript.

Availability of data and materials: The corresponding author can provide the data upon special request. Herbarium specimens have been deposited in public repositories in ANDA and BO.

Competing interests: The authors affirm that they have no competing interests.

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Author contributions: MAR configured the research project. MAR, S, and N designed the study. MAR carried out fieldwork and data analysis. MAR and IPGPD drafted the manuscript. MAR, S, N, and IPGPD carried out data analysis and wrote the manuscript. MAR and IPGPD processed and identified the herbarium specimens. All authors read, reviewed, and approved the final version of the manuscript.

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