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Species diversity and traditional utilization of bamboos (Poaceae) on the Phu Thai Ethnic Group in northeastern Thailand

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Abstract. *Sudchaleaw S, Saensouk S, Saensouk P, Sungkaew S. 2023. Species diversity and traditional utilization of bamboos (Poaceae) on the Phu Thai Ethnic Group in northeastern Thailand. Biodiversitas 24: 2261-2271.* The study of species diversity by survey method and traditional utilization by interviewing local philosophers, folk healers, elders, and villagers with semi-structured interviews of bamboos (Poaceae) in the Phu Thai Ethnic Group in four provinces including Kalasin, Mukdahan, Nakhon Phanom, and Sakon Nakhon Provinces, in the Northeast of Thailand was conducted from May 2019 to August 2021. In addition, the aim of this research is to study the species diversity and traditional utilization of Bamboo (Poaceae) in the Phu Thai Ethnic Group in Nakhon Phanom, Sakon Nakhon, Kalasin, and Mukdahan Provinces, in Northeastern Thailand. Survey Five genera, and 13 species including *Bambusa bambos* (L.) Voss, *B. beecheyana* Munro, *B. burmanica* Gamble, *B. nutans* Wall. ex Munro, *B. spinosa* Roxb., *B. vulgaris* Schrad. ex J.C.Wendl., *Dendrocalamus asper* (Schult. & Schult.f.) Backer ex K. Heyne, *D. giganteus* Munro, *D. sinicus* L.C. Chia & J.L.Sun, *Gigantochloa albociliata* (Munro) Kurz, *Thyrsostachys siamensis* Gamble, ×*Thyrsocalamus liang* Sungkaew & W.L. Goh, and *Vietnamosasa pusilla* (A. Chev. & A. Camus) T.Q. Nguyen were found. The genus with the highest species is *Bambusa*, with seven species, followed by *Dendrocalamus* (3 species). One species per genus was found in the other three genera: *Gigantochloa, Thyrsostachys*, and *Vietnamosasa.* Vernacular name, distribution, ecology, and phenology are present here. The traditional utilization of bamboos in the Phu Thai Ethnic Group in these four provinces indicated that bamboo was used as food for 13 species from five genera. While six species in three genera were used for medicinal purposes, 13 species from five genera were used as equipment, appliances, and housing materials, seven species from four genera were used as ornamental plants, and 13 species from five genera were used in ritualistic ceremonies. The data on species diversity and traditional utilization of bamboos in the Phu Thai Ethnic Group in these four provinces in Northeastern Thailand were newly reported.

Keywords: Bamboo, diversity, ethnobotany, Poaceae, Thailand

INTRODUCTION

Bamboo is a monocotyledon plant belonging to the Poaceae family, widely distributed in most parts of the world. Both in the warm temperate and tropical, especially in the tropical region of Asia, exceptionally in Europe, the Arctic, and the Antarctic. It is well known as the tallest grass in the world, with heights reaching up to 100 feet or more. About 75 genera and *c.* 1,250 species of bamboo are in the world today (Sharma 1980; Bamboo Phylogeny Group (BPG) 2012; Tamang et al. 2013; Kumari 2019). In addition, *c.* 45 genera and *c.* 750 species are distributed in the Southeast (Dransfield 1980, 1998; Yuming et al. 2004; Wong et al. 2016; Goh et al. 2020; Liu et al. 2020, 2022). Also, *c.* 13 genera and *c.* 60 species are found distributed in Thailand (Royal Forest Department 1988), and expected up to 20 genera and upto100 species will be distributed in natural habitats in Thailand (Sangkaew et al. 2018). Several years ago, many species of Bamboo were discovered by several scientists, *i.e.*, *Chimonocalamus auriculatus* Sungkaew, Hodk. & N.H.Xia (Sungkaew et al. 2018), *Chimonocalamus elegans* Sungkaew & Teerawat. (Teerawatananon et al. 2017), *Dendrocalamus khoonmengii* Sungkaew, A. Teerawatananon & Hodk. (Sungkaew et al. 2007), ×*Thyrsocalamus liang* (Goh et al. 2018), *Pseudostachyum polymorphum* Munro (Teerawatananon et al. 2014), *Thyrsostachys oliveri* Gamble (Sungkaew et al. 2021) and *T. siamensis* Gamble (Sungkaew et al. 2021).

In addition, bamboo is a versatile plant that humans use for life. Their way of life and culture has been associated with this plant since ancient times. They are used for food, raw materials, building homes, musical instruments, and medicinal purposes. The indigenous knowledge using bamboo has been passed down from generation to generation in the communities. Still, some have been lost over time due to the social conditions change, and the rural lifestyle was gradually replaced by urban society. Therefore, it should be studied to gather information to inherit this wisdom and not lose any more wisdom in using bamboo. In particular, research on ethnobotany is also related to many other fields, such as taxonomy, ecology, pharmacology, and anthropology. It is also a guideline to extend the local wisdom and develop the use of bamboo for sustainable use in the future (Bystriakova et al. 2003; Pande and Pandey 2008; Kuttiraja et al. 2013; Pholhiamhan et al. 2018; Junsongduang et al. 2020).

These factors significantly contribute to reducing bamboo in nature in local communities of Phu Thai Ethnic groups in Nakhon Phanom, Kalasin, Mukdahan, and Sakon Nakhon provinces, in Northeastern Thailand (Pholhiamhan et al. 2018; Junsongduang et al. 2020). That reduction is due to urban and community development, and utilization to increase agricultural productivity, dredging of swamps, expanding waterways, construction of walls along the canals to prevent erosion, the landscape improvement, including the use of bamboo in terms of food, equipment, appliances, and building houses (Pholhiamhan et al. 2018).

The benefits of bamboos species are widely known (Goh et al. 2018). Phu Thai Ethnic Group has been found to have the most population Nakhon Phanom, Sakon Nakhon, Kalasin, and Mukdahan Provinces, in Northeastern Thailand. While, many species of bamboos such as *Bambusa nutans* Wall. ex Munro, *B. bambos* (L.) Voss, *B. spinosa* Roxb., *Thyrsostachys siamensis* Gamble, and ×*Thyrsocalamus liang* Sungkaew & W.L. Goh were the most used in Northeastern Thailand by Phu Thai Ethnic groups, especially in Nakhon Phanom Province (Pholhiamhan et al. 2018). However, Phu Thai Ethnic Group in Sakon Nakhon, Kalasin, and Mukdahan Provinces never reported before. Therefore, there is a risk of extinction of these plants from their natural habitat (Pholhiamhan et al. 2018; Junsongduang et al. 2020). Regarding conservation, bamboo is a pioneer plant that grows in empty spaces or areas that are invaded and destroyed quickly, thus helping to quickly improve the ecological conditions in the destroyed forest area. It is also a plant with a broad root system that helps prevent embankment erosion. Moreover, planting bamboo along the embankment of the waterways will help preserve the surfaces of the soil's moist and beautiful landscapes. It also helped to improve the soil condition and became the origin of the name "Din Kui Phai" (Bamboo Soil), which is suitable for growing other plants. Therefore, the aim of this research is to study the species diversity and traditional utilization of Bamboo (Poaceae) in the Phu Thai Ethnic Group in four provinces, including Nakhon Phanom, Sakon Nakhon, Kalasin, and Mukdahan Provinces, in Northeastern Thailand.

MATERIALS AND METHODS

Study areas and plant diversity

The study was conducted from May 2019 to August 2021 in Nakhon Phanom, Kalasin, Mukdahan, and Sakon Nakhon Provinces, northeastern Thailand (Figure 1). Bamboo species diversity, vernacular names, distribution data, ecological data, and phenology were recognized in the field. Plant specimens are collected at least five duplicates per plant species with a tag recording the name of the locality, collecting date, collector name, and place of storage based on various botanical documents, e.g., Phengkhlai 1972; Chayamarit 1994; Middleton 2009; Inthachub et al. 2010; Chantaranothai 2011; Poopath et al. 2012; Boonma et al. 2020, 2021; Saensouk and Saensouk 2019; Saensouk et al. 2016, 2021a, 2021b. Plant specimens are deposited at Mahasarakham University Herbarium. Verify scientific names using taxonomic information, the key to species, relative botanical documents, and an online database from the Plant of the World Online (Kew Science 2022). Moreover, the specimens in this study were compared with herbarium specimens that were deposited aboard herbaria in Thailand, i.e., Herbarium of Department of National Parks, Wildlife and Plant Conservation (BKF), Bangkok Herbarium (BK), Queen Sirikit Botanical Gardens Herbarium (QBG) and Khon Kaen University Herbarium (KKU), available taxonomic literature and online images.

Phu Thai Ethnic Group in Nakhon Phanom Province has 4 villages: (i) Na Bua village, Khok Hin Hae Sub-district, Renu Nakhon District, (ii) Fang Nakhon village, Saen Phan Sub-district, That Phanom District, (iii) Phanthakiri village, Saen Phan Nuea Sub-district, That Phanom District, (iv) Mhan Yhon village, Saen Phan Nuea Sub-district, That Phanom District. The climate in Nakhon Phanom Province is hot and humid. The type of ecosystem is deciduous dipterocarp forest, mix-deciduous forest and forest near the watercourse. The most local populations are agriculture, buddhism, and Phu Thai culture. (Pholhiamhan et al. 2018)

Phu Thai Ethnic Group in Kalasin Province has 3 villages: (i) Huay Daeng village, Kut Wa Sub-district, Kuchinarai District, (ii) Nong Hang village, Nong Hang Sub-district, Kuchinarai District, (iii) Khok Kong village, Kut Wa Sub-district, Kuchinarai District. The climate in Kalasin Province is hot and humid. The type of ecosystem is deciduous dipterocarp forest, mix-deciduous forest and forest near the watercourse. The most local populations are agriculture, buddhism, and Phu Thai culture (Phatlamphu et al. 2021).

Phu Thai Ethnic Group in Mukdahan Province has 2 villages: (i) Pao village, Ban Pao Sub-district, Nong Sung District, (ii) Phu village, Ban Pao Sub-district, Nong Sung District. The climate in Mukdahan Province is hot and humid. The type of ecosystem is deciduous dipterocarp forest, mix-deciduous forest and forest near the watercourse. The most local populations are agriculture, buddhism, and Phu Thai culture (Hiroshi 2000).

Phu Thai Ethnic Group in Sakon Nakhon Province has 5 villages: (i) Tha Wat village, Pathum Wapi Sub-district, Song Dao District, (ii) Nong Mek village, Kham Na Tae Sub-district, Kham Ta Kla District, (iii) Phon Thong village, Na Tae Sub-district, Kham Ta Kla District, (iv) Kham Ta Kla village, Kham Ta Kla Sub-district, Kham Ta Kla District, (v) Ti Sombun village, Na Tae Sub-district, Kham Ta Kla District. The climate in Sakon Nakhon Province is hot and humid. The type of ecosystem is deciduous dipterocarp forest, mix-deciduous forest and forest near the watercourse. The most local populations are agriculture and buddhism. All of area studies are Phu Thai culture (Saensouk and Saensouk 2020).

Interview villagers about the local names of each species of bamboo, utilization, and parts of plants that are used in all three aspects, namely plants used as food, medicinal, ornamental plant, and building houses, according to the prepared questionnaire (Pholhiamhan et al. 2018; Junsongduang et al. 2020; Numpulsuksant et al. 2021; Saisor et al. 2021).

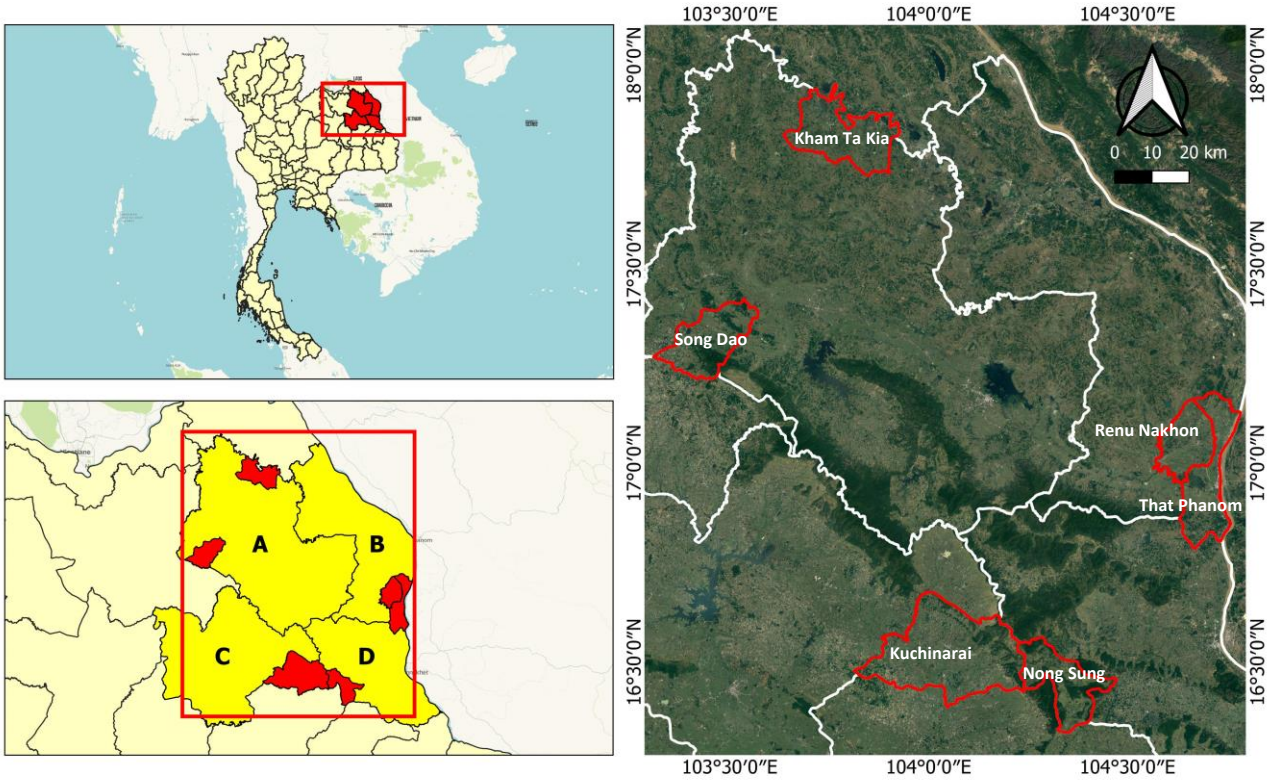

Figure 1. Map of Thailand with divided floristic regions after the "Flora of Thailand" shows the study areas with green part and closed up in the upper right frame, followed by the geographical map of study areas in Sakon Nakhon Province (A), Nakhon Phanom Province (B), Kalasin Province (C), and Mukdahan Province (D). (Thailand. 2023. https://www.google.com/maps/place/Thailand/)

Ethnobotanical data collection

The information on the use of bamboo in the community by interviewing local philosophers, folk healers, elders, and villagers with semi-structured interviews from 14 villages, 40 people per village in four provinces (Figure 1) and field observations were collected data. During the interviews with each informant, information regarding the local names of plants used by the Phu Thai ethnic group, the plant parts used, method of preparations, route of administration, and dosage were recorded. Photographs of plants were provided.

Study of bamboo utilization of the Phu Thai Ethnic Group in four Provinces as follows:

Nakhon Phanom Province by interviewing local philosophers, folk healers, elders, and villagers with semi-structured interviews in 4 villages: (i) Na Bua village, Khok Hin Hae Sub-district, Renu Nakhon District; (ii) Fang Nakhon village, Saen Phan Sub-district, That Phanom District; (iii) Phanthakiri village, Saen Phan Nuea Sub-district, That Phanom District; 4) Mhan Yhon village, Saen Phan Nuea Sub-district, That Phanom District. The survey was conducted from February to March 2020 by interviewing people in the community for 40 local philosophers and folk healers.

Kalasin Province by interviewing local philosophers, folk healers, elders, and villagers with semi-structured interviews in 3 villages as follows: (i) Huay Daeng village, Kut Wa Sub-district, Kuchinarai District; (ii) Nong Hang village, Nong Hang Sub-district, Kuchinarai District; (iii) Khok Kong village, Kut Wa Sub-district, Kuchinarai District. The survey was conducted from February to March 2020 by interviewing people in the community for 40 local philosophers and folk healers.

Mukdahan Province by interviewing local philosophers, folk healers, elders, and villagers with semi-structured interviews in 2 villages as follows: (i) Pao village, Ban Pao Sub-district, Nong Sung District; (ii) Phu village, Ban Pao Sub-district, Nong Sung District. The survey was conducted from February to March 2020 by interviewing community members of 40 local philosophers and folk healers.

Sakon Nakhon Province by interviewing local philosophers, folk healers, elders, and villagers with semi-structured interviews in 5 villages as follows: (i) Tha Wat village, Pathum Wapi Sub-district, Song Dao District; (ii) Nong Mek village, Kham Na Tae Sub-district, Kham Ta Kla District; (iii) Phon Thong village, Na Tae Sub-district, Kham Ta Kla District; 4) Kham Ta Kla village, Kham Ta Kla Sub-district, Kham Ta Kla District; 5) Ti Sombun village, Na Tae Sub-district, Kham Ta Kla District. The survey was conducted from February to March 2020 by interviewing people in the community for 40 local philosophers and folk healers.

Quantitative analysis index

The quantitative data analysis on the ethnobotanical index to calculate the Use Value (UV) (Phillips et al. 1994), Jaccard's Similarity Index (JI) (Jaccard 1908), Cultural Importance Index (CI) (Inta et al. 2008; Phatlamphu et al. 2021).

Uses Value (UV)

The Uses Value is high when there are many uses reports for a plant and indicates that the plant is very important to the community. In contrast, the low value or approach zero indicates that the plant has few reports of uses or is used less often than plants with high UV Value. However, the UV value does not distinguish whether a plant is used for single or multiple purposes.

$$UV = \frac{U_i}{N}$$

Where:
*U*i : number of use reports cited by each informant for a given species
N : Total number of informants

Jaccard's Similarity Index (JI)

This index was calculated to compare the uses of the plant in two areas that were dominated by the different study areas.

$$JI = \frac{c}{(a+b+c)}$$

Where:
a : Number of species used in area A
b : number of species used in area B
c : number of species used in both areas A and B

Cultural Importance Index (CI)

CI index is the sum of the proportion of informants that mention each species for their use categories, used to demonstrate how important bamboo is for the community based on the data from interviews and questionnaires. The highest CI value equals the use category type, meaning all informants mentioned that the plant was used in all categories.

$$CI = \sum_{u=1}^{NC} \sum_{i=1}^{N} \frac{UR_u}{N}$$

Where:
NC : Total number of use categories
UR_{ui} : Total number of use reports
N : Total number of informants

RESULTS AND DISCUSSION

Species diversity of bamboo in northeastern communities of Thailand

The study of species diversity of Bamboo (Poaceae) in Northeastern Communities of Thailand and their utilization with particular emphasis on the Phu Thai Ethnic Group found 5 genera and 13 species, including *Bambusa bambos* (L.) Voss, *B. beecheyana* Munro, *B. burmanica* Gamble, *B. nutans* Wall. ex Munro ex Munro, *B. spinosa* Roxb., *B. vulgaris* Schrad. ex J.C.Wendl., *Dendrocalamus asper* (Schult. & Schult.f.) Backer ex K. Heyne, *D. giganteus* Munro, *D. sinicus* L.C. Chia & J.L.Sun, *Gigantochloa albociliata* (Munro) Kurz, *Thyrsostachys siamensis* Gamble, ×*Thyrsocalamus liang* Sungkaew & W.L. Goh, and *Vietnamosasa pusilla* (A. Chev. & A. Camus) T.Q. Nguyen. The genus with the highest species is *Bambusa*, with seven species, followed by *Dendrocalamus* (three species). One species per genus was found in the other three genera: *Gigantochloa*, *Thyrsostachys*, and *Vietnamosasa*. The vernacular name, distribution, ecology, and phenology of Bamboo (Poaceae) species in this study are present here.

Bambusa bambos (L.) Voss (Figure 2A)

Vernacular name: Phai Pa.

Distribution: It was found as native to Assam, Bangladesh, Cambodia, India, Laos, Myanmar, Sri Lanka, Thailand, and Vietnam.

Ecology: In the deciduous dipterocarp forest near the watercourse and the mix-deciduous forest.

Phenology: Flower and fruit are not seen.

Bambusa beecheyana Munro (Figure 2B)

Vernacular name: Phai Kimsung.

Distribution: It was found as native to China South-Central, China Southeast, Hainan, Myanmar, Taiwan, and Vietnam. Whereas this species was the first time reported in Thailand.

Ecology: Near the deciduous dipterocarp forest and the mix-deciduous forest near the watercourse.

Phenology: Flower and fruit are not seen.

Bambusa burmanica Gamble (Figure 2C)

Vernacular name: Phai Whan.

Distribution: It was found as native to Bangladesh, China South-Central, Laos, Malaya, Myanmar, and Thailand.

Ecology: In the deciduous dipterocarp forest near the watercourse and the mix-deciduous forest.

Phenology: Flowering in May to October, fruit not seen.

Bambusa nutans Wall ex Munro. (Figure 2D)

Vernacular name: Phai Bong.

Distribution: It was found as native to Assam, Bangladesh, East Himalaya, India, Laos, Nepal, Thailand, Vietnam, and West Himalaya.

Ecology: In the deciduous dipterocarp forest near the watercourse and the mix-deciduous forest.

Phenology: Flowering in March, Fruit not seen.

Bambusa spinosa Roxb. (Figure 2E)

Vernacular name: Phai Si Suk, Phai Yai.

Distribution: It was found native to Borneo, Jawa, Lesser Sunda Is., Maluku, Philippines, and Sulawesi. While, this species is introduced into Bangladesh, Cambodia, China South-Central, China Southeast, Laos,

Malaya, Nansei-Shoto, Puerto Rico, Taiwan, Vietnam, including Thailand.

Ecology: In the deciduous dipterocarp and mix-deciduous forest near the watercourse.

Phenology: Flowering not seen, fruit not seen.

Bambusa vulgaris Schrad. ex J.C.Wendl. (Figure 2F)

Vernacular name: Phai Lueang, Phai Jeen.

Distribution: It was found as native to Cambodia, China South-Central, Laos, Myanmar, Thailand, and Vietnam.

Ecology: In the deciduous dipterocarp forest near the watercourse and the mix-deciduous forest.

Phenology: Flowering in April, Fruit not seen.

Dendrocalamus asper (Schult. & Schult.f.) Backer ex K. Heyne (Figure 2G)

Vernacular name: Phai Tong.

Distribution: It was found as native to Andaman Is., Bangladesh, Borneo, China South-Central, China Southeast, Jawa, Laos, Lesser Sunda Is., Malaya, Maluku, Myanmar, New Guinea, Philippines, Sulawesi, Sumatera, Taiwan, Thailand, and Vietnam.

Ecology: In the deciduous dipterocarp forest near the watercourse and the mix-deciduous forest.

Phenology: Flowering in October, fruit not seen.

Dendrocalamus giganteus Munro (Figure 2H)

Vernacular name: Phai Poah.

Distribution: It was found as native to Assam, China South-Central, East Himalaya, India, Laos, and Myanmar. This species was introduced into Bangladesh, Cambodia, Comoros, Ecuador, Jawa, Lesser Sunda Is., Madagascar, Malaya, Mauritius, Nepal, Puerto Rico, Seychelles, Sri Lanka, Sumatera, Taiwan, Trinidad-Tobago, Vietnam, including Thailand.

Ecology: In the deciduous dipterocarp forest near the watercourse and the mix-deciduous forest.

Phenology: Flowering almost all year, fruit not seen.

Dendrocalamus sinicus L.C. Chia & J.L.Sun (Figure 2I)

Vernacular name: Phai Chin.

Distribution: It was found as native to South-Central China and Laos. Whereas, this species was the first time reported in Thailand.

Ecology: In the deciduous dipterocarp forest near the watercourse and the mix-deciduous forest.

Phenology: Flowering almost all year, fruit not seen.

Gigantochloa albociliata (Munro) Kurz (Figure 2J)

Vernacular name: Phai Rai, Mai Rai, Phai Khai.

Distribution: It was found as native to Assam, Bangladesh, China South-Central, East Himalaya, Laos, Myanmar, Thailand, and Vietnam.

Ecology: In the deciduous dipterocarp forest near the watercourse and the mix-deciduous forest.

Phenology: Flowering in March, Fruit not seen.

Thyrsostachys siamensis Gamble (Figure 2K)

Vernacular name: Phai Huak, Phai Ruak.

Distribution: It was found as native to Cambodia, China South-Central, Laos, Myanmar, Thailand, and Vietnam.

Ecology: In the deciduous dipterocarp forest and mix-deciduous forest.

Phenology: Flowering in November.

×*Thyrsocalamus liang* Sungkaew & W.L. Goh (Figure 2L)

Vernacular name: Phai Chiang Prai, Phai Leang, Phai Srang Prai.

Distribution: It was found as native to China South-Central, China Southeast, East Himalaya, Hainan, Laos, Myanmar, Nepal, Taiwan, and Vietnam. While, this species was the first time reported in Thailand.

Ecology: In the deciduous dipterocarp forest near the watercourse and the mix-deciduous forest.

Phenology: Flowering in October, mature fruit found in April.

Vietnamosasa pusilla (A.Chev. & A.Camus) T.Q.Nguyen (Figure 2M)

Vernacular name: Phai Pek.

Distribution: It was found as native to Cambodia, Laos, Thailand, and Vietnam.

Ecology: In the deciduous dipterocarp forest near the watercourse and the mix-deciduous forest.

Phenology: Flowering in April, Fruit not seen.

Traditional utilization of bamboo in the Phu Tai ethnic group

A study of species diversity of bamboo in Northeastern Communities of Thailand and their Utilization with Particular Emphasis on the Phu Thai Ethnic Group located in Nakhon Phanom, Kalasin, Mukdahan, and Sakon Nakhon provinces. The interviewees were in 14 villages in 4 provinces, namely Nakhon Phanom, Kalasin, Mukdahan, and Sakon Nakhon province found that there are 5 genera of 13 species of bamboo used for utilization, are shown in Table 1, along with their vernacular name.

Plant Utilization Index (Use Value, UV)

When considering the utilization index (Use value, UV) of bamboos in the Phu Tai Ethnic Group in Nakhon Phanom, Kalasin, Mukdahan, and Sakon Nakhon provinces, as shown in Table 1. It's also one causing the risk of extinction of such plants from the forest area studied. But on the other hand, the low Use Value (UV) may indicate that people are less interested in these plant species, making them less at risk of extinction.

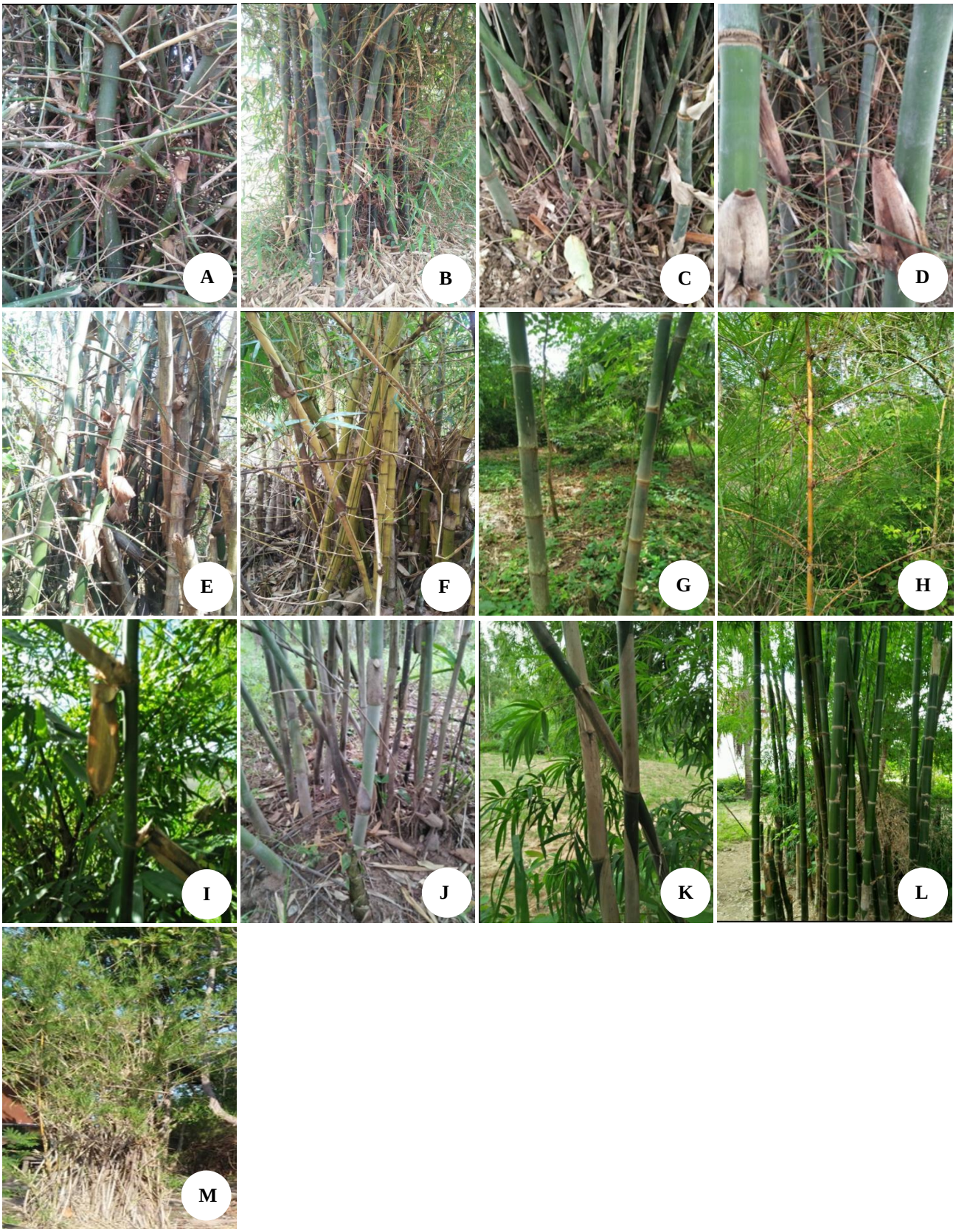

Figure 2. The species diversity, some morphological characteristic and traditional utilization of Bamboo (Poaceae) some species in the Phu Thai Ethnic Group in Nakhon Phanom, Sakon Nakhon, Kalasin, and Mukdahan Provinces, in Northeastern Thailand. A. *Bambusa bambos*, B. *B. beecheyana*, C. *B. burmanica*, D. *B. nutans*, E. *B. spinosa*, F. *B. vulgaris*, G. *Dendrocalamus asper*, H. *D. giganteus*, I. *D. sinicus*, J. *Gigantochloa albociliata*, K. *Thyrsostachys siamensis*, L. ×*T. liang*, M. *Vietnamosasa pusilla*

The utilization of bamboo by the Phu Tai Ethnic Group in Nakhon Phanom Province

The villagers utilized bamboo from all three species: *D. asper*, ×*T. liang*, and *B. spinosa*. The benefits in each aspect are as follows: (i) For food, young shoots are cut/chopped into small pieces and then fermented, boiled, and eaten with chili paste, or used to make bamboo shoot soup or curry. (ii) For housing equipment, parts of the trunk are used to make equipment and wickerwork, such as baskets and knots, Kratib (sticky rice container), Sai (Fish trap), Vase, Hats, Wardrobes, Pantry, Tables, Chairs, Cart, including to build houses and fences. (iii) For ritual, the parts of the stem are weaved into a Sai (Fish trap) used in the main pillar ceremony before building a house. Then, weave and make Chalaew (a container for offerings) in the ceremony to receive the gift of the Mae Phosop goddess. In addition, they made a fireboat frame for the Lai Ruea Fai Festival, used to weave a Khong (container for holding fish), and used it in the ceremony to drive away ghouls. The utilization of bamboo by the Phu Thai Ethnic Group in Nakhon Phanom Province is shown in Table 2.

The utilization of bamboo by the Phu Tai Ethnic Group in Kalasin Province

The villagers utilized bamboo from all nine Species in five genera as follows: *B. bambos*, *B. burmanica*, *B. nutans*, *B. spinosa*, *D. asper*, *D. giganteus*, *G. albociliata T. siamensis*, and ×*T. liang*. The benefits in each aspect are as follows: (i) For food, young shoots are cut/chopped into small pieces, then fermented, boiled, and eaten with chili paste or used to make bamboo shoot soup or curry. (ii) For medicinal, local people do not use bamboos for medicine. (iii) For housing equipment, parts of the trunk are used to make equipment and wickerwork, such as baskets and knots, Kratib (sticky rice container), Sai (Fish trap), Vase, Hats, Wardrobes, Pantry, Tables, Chairs, Cart, including to build houses and fences. (iv) For ornamentals, bamboo is planted as an ornamental plant in the home garden and includes planted bamboo in a row to make bamboo fences alive. (v) For ritual, used in the main pillar ceremony before building a house. Weave and make Chalaew (a container for offerings) in the ceremony to receive the gift of the Mae Phosop goddess, used to weave a Khong (container for holding fish), and to be used in the ceremony to drive away ghouls. The bamboo utilization in the Phu Thai Ethnic Group in Kalasin Province is shown in Table 2.

The utilization of bamboo by the Phu Tai ethnic group in Mukdahan Province

The result found that the villagers utilized bamboo as food and for ritual 12 species, used as housing equipment and housed 11 species, and for ornamental purposes six species as shown in Table 2. The benefits in each aspect are as follows: (i) For food, young shoots are cut/chopped into small pieces, then fermented, boiled, and eaten with chili paste or used to make bamboo shoot soup or curry. (ii) For medicinal, local people do not use bamboos for medicine. (iii) For housing equipment, parts of the trunk are used to make equipment and wickerwork, such as baskets and knots, Kratib (sticky rice container), Sai (Fish trap), Vase, Hats, Wardrobes, Pantry, Tables, Chairs, Cart, including to build houses and fences. (iv) For ornamentals, bamboo is planted as an ornamental plant in the home garden and includes planted bamboo in a row to make bamboo fences alive. (v) For ritual, used in the main pillar ceremony before building a house. Weave and make Chalaew (a container for offerings) in the ceremony to receive the gift of the Mae Phosop goddess, used to weave a Khong (container for holding fish), and to be used in the ceremony to drive away ghouls. The bamboo utilization in the Phu Thai Ethnic Group in Mukdahan Province is shown in Table 2.

Table 1. List of species of bamboos used by the Phu Thai Ethnic group in Nakhon Phanom, Kalasin, Mukdahan, and Sakhon Nakhon provinces, Thailand with the Use Value (UV) of each species in each province

Scientific name	Vernacular name	Use Value (UV)				Collection no.
		Nakhon Phanom	Kalasin	Mukdahan	Sakon Nakhon	
Bambusa bambos	ไผ่ป่า (Phai Pa)	-	0.65	0.25	0.58	Samruay 5, 18, 27
B. beecheyana	ไผ่กิมซุง (Phai Kimsung)	-	-	-	0.08	Samruay 34
B. burmanica	ไผ่หวาน (Phai Whan)	-	0.10	0.10	0.05	Samruay 12, 23, 35
B. nutans	ไผ่บง (Phai Bong)	-	**0.70**	0.15	0.38	Samruay 4, 21, 29
B. spinosa	ไผ่สีสุก (Phai Si Suk)	**1.00**	0.45	**0.53**	**0.93**	Samruay 1, 10, 14, 25
B. vulgaris	ไผ่เหลือง (Phai Lueang)	-	-	0.18	0.18	Samruay 20, 32
Dendrocalamus asper	ไผ่ตง (Phai Tong)	0.43	0.53	0.33	0.40	Samruay 3, 8, 16, 28
D. giganteus	ไผ่เปาะ (Phai Poah)	-	0.23	0.10	0.15	Samruay 11, 22, 33
D. sinicus	ไผ่จีน (Phai Chin)	-	-	0.08	0.05	Samruay 24, 36
Gigantochloa albociliata	ไผ่ไร่ (Phai Rai)	-	0.60	0.43	0.25	Samruay 6, 15, 31
Thyrsostachys siamensis	ไผ่รวก (Phai Ruak)	-	0.53	**0.53**	0.28	Samruay 9, 13, 30
×*T. liang*	ไผ่เลี้ยง (Phai Leang)	0.55	0.58	0.33	0.60	Samruay 2, 7, 17, 26
Vietnamosasa pusilla	ไผ่เพ็ก (Phai Phek)	-	-	0.20	-	Samruay 19

Note: A cell without the Use Value means no species found or use found in that province

Table 2. List of species in the Bamboo species used by the Phu Thai Ethnic group in northeastern Thailand provinces with used parts in each benefits type, sorted from highest to lowest UV value

Scientific name	Used parts in each benefits type					UV	Collection no.
	Food	Medicinal	Appliances & housing	Ornamental	Rite		
Nakhon Phanom							
Bambusa spinosa	Young shoots	-	Stems	-	Stems	1.00	Samruay 1
×Thyrsocalamus liang	Young shoots	-	Stems	-	Stems	0.55	Samruay 2
Dendrocalamus asper	Young shoots	-	Stems	-	Stems	0.43	Samruay 3
Kalasin							
Bambusa nutans	Young shoots	-	Stems	All plants	Stems	0.70	Samruay 4
B. bambos	Young shoots	-	Stems	-	Stems	0.65	Samruay 5
Gigantochloa albociliata	Young shoots	-	Stems	All plants	Stems	0.60	Samruay 6
×Thyrsocalamus liang	Young shoots	-	Stems	All plants	Stems	0.58	Samruay 7
Dendrocalamus asper	Young shoots	-	Stems	All plants	Stems	0.53	Samruay 8
T. siamensis	Young shoots	-	Stems	All plants	Stems	0.53	Samruay 9
B. spinosa	Young shoots	-	Stems	-	Stems	0.45	Samruay 10
D. giganteus	Young shoots	-	Stems	-	Stems	0.23	Samruay 11
B. burmanica	Young shoots	-	Stems	All plants	Stems	0.10	Samruay 12
Mukdahan							
Thyrsostachys siamensis	Young shoots	-	Stems	All plants	Stems	0.53	Samruay 13
Bambusa spinosa	Young shoots	-	Stems	-	Stems	0.53	Samruay 14
Gigantochloa albociliata	Young shoots	-	Stems	All plants	Stems	0.43	Samruay 15
Dendrocalamus asper	Young shoots	-	Stems	-	Stems	0.33	Samruay 16
×T. liang	Young shoots	-	Stems	All plants	Stems	0.33	Samruay 17
B. bambos	Young shoots	-	Stems	All plants	Stems	0.25	Samruay 18
Vietnamosasa pusila	Young shoots	-	Stems	-	Stems	0.20	Samruay 19
B. vulgaris	Young shoots	-	Stems	-	Stems	0.18	Samruay 20
B. nutans	Young shoots	-	Stems	All plants	Stems	0.15	Samruay 21
D. giganteus	Young shoots	-	Stems	-	Stems	0.10	Samruay 22
B. burmanica	Young shoots	-	Stems	-	Stems	0.10	Samruay 23
D. sinicus	Young shoots	-	-	-	Stems	0.08	Samruay 24
Sakon Nakhon							
Bambusa spinosa	Young shoots	Young shoots, roots, leaves	Stems	-	Stems	0.93	Samruay 25
×Thyrsocalamus liang	Young shoots	Young shoots	Stems		Stems	0.60	Samruay 26
B. bambos	Young shoots	Young shoots	Stems	All plants	Stems	0.58	Samruay 27
Dendrocalamus asper	Young shoots	-	Stems	-	Stems	0.40	Samruay 28
B. nutans	Young shoots	Young shoots, roots, leaves	Stems	All plants	Stems	0.38	Samruay 29
T. siamensis	Young shoots	Young shoots	Stems	All plants	Stems	0.28	Samruay 30
Gigantochloa albociliata	Young shoots	Root, young shoots	Stems	All plants	Stems	0.25	Samruay 31
B. vulgaris	Young shoots	Young shoots, roots, and water from the stems	Stems	All plants	Stems	0.18	Samruay 32
D. giganteus	Young shoots	-	Stems	-	Stems	0.15	Samruay 33
B. beecheyana	Young shoots	Young shoots, water from stems	Stems	-	Stems	0.08	Samruay 34
D. giganteus	Young shoots	-	Stems	-	Stems	0.05	Samruay 35
D. sinicus	Young shoots	-	Stems	-	Stems	0.05	Samruay 36

The utilization of bamboo by the Phu Tai Ethnic Group in Sakon Nakhon Province

The villagers utilized bamboo for food, ritual and housing equipment for 12 species, and for medicinal purposes eight species, as shown in Table 2. The benefits in each aspect are as follows: (i) For food, young shoots are cut/chopped into small pieces, then fermented, boiled, and eaten with chili paste or used to make bamboo shoot soup or curry. (ii) For herbal purposes, the roots and the leaves are boiled, then drink the water to help dissolve phlegm, treat diarrhea, expel wind, urinate, menstruate, and cure endometritis. Young shoots are used for cooking, helping dissolves phlegm, solving diarrhea, treating drive wind, and treating liver and spleen diseases. The water from the stems is brought to drink to treat diabetes, high blood pressure, gout, paresis, trigger finger, gallstones, etc. (iii) For housing equipment, parts of the trunk are used to make equipment and wickerwork, such as baskets and knots, Kratib (sticky rice container), Sai (Fish trap), Vase, Hats, Wardrobes, Pantry, Tables, Chairs, Cart, including to build houses and fences. (iv) For ornamentals, bamboo is planted as an ornamental plant in the home garden and includes planted bamboo in a row to make bamboo fences alive. (v) For ritual, used in the main pillar ceremony before building a house. Weave and make Chalaew (a container for offerings) in the ceremony to receive the gift of the Mae Phosop goddess, used to weave a Khong (container for holding fish), and to be used in the ceremony to drive away ghouls. The bamboo utilization of the Phu Thai Ethnic Group in Sakon Nakhon Province is shown in Table 2.

Table 3. Similarity index (Jaccard index, JI) of the utilization of species in the Bamboo species by the Phu Thai Ethnic group in Nakhon Phanom, Kalasin, Mukdahan, and Sakon Nakhon provinces of Northeastern Thailand

Study area	Number of species found in the area
Sakon Nakhon Province (A)	12
Nakhon Phanom Province (B)	3
Kalasin Province (C)	9
Mukdahan Province (D)	12
[A ∩ B ∩ C ∩ D] = (E)	3
Similarity index (Jaccard index; JI)	7.69

The similarities index in the bamboo utilization of the Phu Tai Ethnic Group. The similarity index (Jaccard index, JI) was used to analyze the relationship between the utilization of bamboo among the Phu Thai Ethnic group by interviewing local philosophers, folk healers, elders, and villagers with semi-structured interviews. That interview was conducted in 14 villages in 4 provinces, namely Nakhon Phanom, Kalasin, Mukdahan, and Sakon Nakhon province. The result found that the similarity index (JI) in using bamboo of the Phu Thai Ethnic group in each area was 7.69. It means that if the JI is greater than 1 or equal to 1, bamboo has been utilized in the Phu Tai Ethnic group. The results in each area are similar, as shown in Table 3. The most number of species to be 12 species have been found in Sakon Nakhon Province and Mukdahan Province. While, nine species were found in Kalasin Province. Three species was discovered in Nakhon Phanom Province (Table 3). Three species, namely *B. spinosa*, *D. asper*, and ×*T. liang* were found in all four provinces. *Bambusa beecheyana* was found only in Sakon Nakhon Province. *Vietnamosasa pusila* was found only in Mukdahan Province.

Discussion

The study of species diversity of Bamboo (Poaceae) in Northeastern Communities of Thailand and their utilization with particular emphasis on the Phu Thai Ethnic Group found 13 species from five genera, including *Bambusa bambos*, *B. beecheyana*, *B. spinosa*, *B. burmanica*, *B. nutans*, *B. vulgaris*, *Dendrocalamus asper*, *D. giganteus*, *D. sinicus*, *Gigantochloa albociliata*, *Thyrsostachys siamensis*, ×*T. liang*, and *Vietnamosasa pusilla*.

In Nakhon Phanom province, three bamboo species were used, including *B. spinosa*, and *D. asper*, and ×*T. liang*. Their young shoots are used for food, housing equipment, building house, and rituals. In Kalasin province, nine Species in five genera were used, including *B. bambos*, *B. burmanica*, *B. nutans*, *B. spinosa*, *D. asper*, *D. giganteus*, *G. albociliata*, *T. siamensis*, and ×*T. liang* used the young shoot for food, mature stem for making housing equipment, to build houses and fences, planting as ornamental, and used for rituals. In Mukdahan province, 12 species of bamboo were used, including *B. bambos*, *B. spinosa*, *B. burmanica*, *B. nutans*, *B. vulgaris*, *D. asper*, *D. giganteus*, *D. sinicus*, *G. albociliata*, *T. siamensis*, ×*T. liang* and *V. pusilla* to use as food, housing equipment, housing, ornamental, and for rituals. While in Sakon Nakhon Province, 12 species of bamboo were used for food, herbal purposes, housing equipment, building houses, ornamental plants, and rituals, including *B. bambos*, *B. beecheyana*, *B. spinosa*, *B. burmanica*, *B. nutans*, *B. vulgaris*, *D. asper*, *D. giganteus*, *D. sinicus*, *G. albociliata*, *T. siamensis*, and ×*T. liang*.

This is consistent with the report of Thavorn and Phetthongma (2014). In Thailand, 13 genera, 69 species of bamboo were found in mixed forests, humid rain forests, and evergreen hill forests, and some species have been planted until they are generally known. It was found that 62 species of bamboo were utilized, of which 12 genera and 45 species were native to Thailand. The utilization of food, residential appliances, ornamental plants, and rituals was also reported. Similarly to the report of Bendem-Alee (2014), bamboo has been utilized for the structure of the Angel's House, along with banana leaves, coconut leaves, and flowers used for decoration, which is used in the Khuan So ceremony but did not mention the species of bamboo used. And also consistent with Buranapim and Jitkaew (2004) reporting the use of bamboo in the production of appliances and wickerwork. In addition, it is consistent with Pornwanichphong and Rittirod (2013), who reported bamboo utilization of bamboo products occupational development group. Ban Khaen Kham, Rai Noi Subdistrict, Mueang District, Ubon Ratchathani Province, uses bamboo in producing decorations, souvenirs, and bamboo piggy banks. Also, to be developed into a 5-star OTOP product of the village, but it does not specify the bamboo species utilized.

The study of species diversity of Bamboo (Poaceae) in Northeastern Communities of Thailand and their utilization, with particular emphasis on the Phu Thai Ethnic Group, found five genera and 13 species, including *Bambusa bambos*, *B. beecheyana*, *B. spinosa*, *B. burmanica*, *B. nutans*, *B. vulgaris*, *Dendrocalamus asper*, *D. giganteus*, *D. sinicus*, *Gigantochloa albociliata*, *Thyrsostachys siamensis*, ×*T. liang*, and *Vietnamosasa pusilla*. The genus with the highest species is *Bambusa*, with seven species, followed by *Dendrocalamus* (three species). One species per genus was found in the other three genera: *Gigantochloa*, *Thyrsostachys*, and *Vietnamosasa*. Twelve species, i.e., *Bambusa bambos*, *B. beecheyana*, *B. burmanica*, *B. nutans*, *B. vulgaris*, *Dendrocalamus asper*, *D. giganteus*, *D. sinicus*, *Gigantochloa albociliata*, *Thyrsostachys siamensis*, ×*T. liang* and *Vietnamosasa pusilla* were distributed in mainland as native to Assam, Bangladesh, Cambodia, India, Laos, China South-Central, China Southeast, Hainan, Myanmar, Taiwan, Sri Lanka, Thailand, and Vietnam. While, two species, *B. spinosa* and *D. asper*, were found in Island as native to Andaman Is., Borneo, Jawa, Lesser Sunda Is., Maluku, Philippines, Sulawesi, New Guinea, Philippines, Sulawesi, Sumatera. While, this species is introduced into Bangladesh, Cambodia, China South-Central, China Southeast, Laos, Malaya, Myanmar, Nansei-Shoto, Puerto Rico, Taiwan, Vietnam, including Thailand. Only *D. asper* was discovered in both areas (mainland and Island). The ecology of all species has been found in the

deciduous dipterocarp forest, the deciduous dipterocarp forest near the watercourse, the mix-deciduous forest and the mix-deciduous forest near the watercourse. The flowering period of four species, namely *B. nutans*, *B. vulgaris*, *Vietnamosasa pusilla*, and *Gigantochloa albociliata* was bloomed in March and April. Two species, *D. asper* and ×*T. liang* have been found during the flowering period in October. Only *B. burmanica* was reported to have a flowering period from May to October. Only *T. siamensis* was reported to have a flowering period in November. Moreover, the flowering period of two species, *D. giganteus* and *D. sinicus* have been found almost all year. The result found that the fruit was found only ×*T. liang* in April.

The utilization of bamboo with particular emphasis on the Phu Thai Ethnic Group in four provinces, including Nakhon Phanom, Sakon Nakhon, Kalasin, and Mukdahan Provinces, found that bamboo was used as food for 13 species from five genera. In addition, six species from three genera were used for medicinal purposes, 13 from five genera were used as equipment, appliances, and building houses, seven from 4 genera were used as ornamental plants, and 13 from five genera were used in ritualistic ceremonies. The utilization index (Use value, UV) of bamboos in the Phu Tai Ethnic Group in Nakhon Phanom, Kalasin, Mukdahan, and Sakon Nakhon provinces found that *Bambusa spinosa* indicated the highest use value in three provinces: Nakhon Phanom (UV = 1.00), Mukdahan (UV = 0.53), and Sakon Nakhon (UV = 0.93), whereas *B. nutans* was indicated highest use value in Kalasin province as UV = 0.70. The villagers in the Phu Thai Ethnic Group in Nakhon Phanom province utilized bamboos for food, housing equipment, and ritual from all three species: *B. spinosa*, *D. asper*, and ×*T. liang*. The villagers in the Phu Thai Ethnic Group in Kalasin Province utilized bamboos for food, medicinal, housing equipment, ornamentals, and ritual from all nine species in five genera as follows: *B. bambos*, *B. burmanica*, *B. nutans*, *B. spinosa*, *D. asper*, *D. giganteus*, *G. albociliata*, *T. siamensis*, and ×*T. liang*. The villagers in the Phu Thai Ethnic Group in Mukdahan Province utilized bamboos as food and for rituals 12 species, used as housing equipment and house 11 species, and for ornamental purposes six species. The villagers of the Phu Thai Ethnic Group in Sakon Nakhon Province utilized bamboo for food, ritual and housing equipment for 12 species, and for medicinal purposes eight species. The similarity index (JI) in using bamboo of the Phu Thai Ethnic group in each area was 7.69.

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REFERENCES

Bamboo Phylogeny Group (BPG). 2012. An Updated Tribal and Subtribal Classification of the Bamboos (Poaceae: Bambusoideae). J Am Bamboo Soc 24 (1): 1-10.

Bendem-Alee S. 2014. "Rab Tiam Da": Rituals, beliefs, and community practices the picture reflects the relationship between man and nature. J Acad Humanit Soc Sci 22 (39): 215-239.

Boonma T, Saensouk S, Saensouk P. 2020. Two new species of *Kaempferia* L. (Zingiberaceae) from Thailand. Taiwania 65 (3): 371-381. DOI: 10.6165/tai.2020.65.371.

Boonma T, Saensouk S, Saensouk P. 2021. *Kaempferia nigrifolia* (Zingiberaceae), a new species from Central Thailand. Rheedea 31 (1): 11-17. DOI: 10.22244/rheedea.2020.31.01.02.

Buranapim A, Jitkaew M. 2004. Basketry of bamboo products. Bureau of Economic Research and Forest Products, Royal Forest Department, Bangkok.

Bystriakova N, Kapos V, Stapleton C, Lysenko I. 2003. Bamboo Biodiversity. UNEPWCMC/INBAR. Swaingrove Imaging, UK.

Chantaranothai P. 2011. A revision of the genus *Vitex* (Lamiaceae) in Thailand. Trop Nat Hist 11(2): 91-118.

Chayamarit K. 1994. Preliminary checklist of the family Anacardiaceae in Thailand. Thai For Bull (Bot) 22: 1-25.

Dransfield S. 1980. Bamboo taxonomy in the Indo-Malesian region. Bamboo Research in Asia: Proceedings of a workshop held in Singapore, 28-30 May 1980. IDRC, Ottawa, ON, CA.

Dransfield S. 1998. Report on fieldwork collecting bamboos in Thailand October-November. Thai For Bull (Bot) 26: 35-39.

Goh WL, Sungkaew S, Teerawatananon A, Ohrnberger D, Widjaja AW, Sabu KK, Gopakumar B, Koshy KC, Xia NH, Wong KM. 2020. The phylogenetic position and taxonomic status of the Southeast and South Asian bamboo genera *Neohouzeaua* and *Ochlandra* (Poaceae: Bambusoideae). Phytotaxa 472 (2): 23 November 2020. DOI: 10.11646/phytotaxa.472.2.2.

Goh WL, Sungkaew S, Teerawatananon A, Ohrnberger D, Xia NH, Chan KS, How YX, Wong KM. 2018. The hybrid origin of Phai Liang, a bamboo of recent introduction into horticulture in Southeast Asia, and a new nothogenus, ×*Thyrsocalamus* (Bambuseae: Bambusinae). Phytotaxa 362 (3): 271-281. DOI: 10.11646/phytotaxa.362.3.3.

Hiroshi H. 2000. The Mekong: Environment and Development. The United Nations University Press, Tokyo, New York, Paris.

Inta A, Shengji P, Balslev H, Wangpakapattanawong P, Trisonthi C. 2008. A comparative study on medicinal plants used in Akha's traditional medicine in China and Thailand, cultural coherence or ecological divergence. J Ethnopharmacol 116 (3): 508-517. DOI: 10.1016/j.jep.2007.12.015.

Inthachub P, Vajrodaya S, Duyfjes BEE. 2010. Census of *Stemona* (Stemonaceae) in Thailand. Blumea-Biodivers Evol Biogeogr Plants 55 (2): 143-152. DOI: 10.3767/000651910X526717.

Jaccard P. 1908. Nouvelles recherches sur la distribution florale. Bulletin de la Société vaudoise des Sciences Naturelles 44: 223-270.

Junsongduang A, Kasemwan W, Lumjoomjung S, Sabprachai W, Tanming W, Balslev H. 2020. Ethnomedicinal knowledge of traditional healers in Roi Et, Thailand. Plants 9 (9): 1177. DOI: 10.3390/plants9091177.

Kumari P. 2019. The bambusoideae in India: An updated enumeration. Plantae Scientia 1 (6): 99-117. DOI:10.32439/PS.V1I06.99-117.

Kuttiraja M, Sindhu R, Varghese PE, Sandhya SV, Binod P, Vani S, Sukumaran RK. 2013. Bioethanol production from bamboo (*Dendrocalamus* sp.) process waste. Biomass Bioenergy 59: 142-150. DOI: 10.1016/j.biombioe.2013.10.015.

Liu J-X, Xu Z-C., Zhang Y-X, Zhou M-Y, Li D-Z. 2022. The identity of Dinochloa species and enumeration of Melocalamus (Poaceae: Bambusoideae) in China. Plant Diversity 45 (2): 133-146. DOI: 10.1016/j.pld.2022.07.001.

Liu J-X, Zhou M-Y, Yang G-Q, Zhang Y-X, Ma P-F, Guo C, Vorontsova MS, Li D-Z. 2020. ddRAD analyses reveal a credible phylogenetic relationship of the four main genera of *Bambusa- Dendrocalamus-Gigantochloa* complex (Poaceae: Bambusoideae). Mol Phylogenet Evol 146: 106758. DOI: 10.1016/j.ympev.2020.106758.

Middleton DJ. 2009. An update on the Apocynaceae in Thailand. Thai For Bull (Bot) 37: 143-155.

Numpulsuksant W, Saensouk S, Saensouk, P. 2021. Diversity and ethnobotanical study of medicinal plants in Ban Hua Kua, Kae Dam

District, Thailand. Biodiversitas 22 (10): 4349-4357. DOI: 10.13057/biodiv/d221027.
Pande SK, Pandey S. 2008. Bamboo for the 21st century. Intl For Rev 10 (2): 134-146. DOI: 10.1505/ifor.10.2.134.
Phatlamphu N, Saensouk S, Saensouk P, Jungsongduang A. 2021. Ethnobotany of edible plants in Muang District, Kalasin Province, Thailand. Biodiversitas 22 (12): 5432-5444. DOI: 10.13057/biodiv/d221225.
Phengkhlai C. 1972. The genus *Diospyros* L. (Ebenaceae) in Thailand. Thai For Bull (Bot) 6: 1-27.
Phillips O, Gentry AH, Reynel C, Wilkin P, Gálvez-Durand BC. 1994. Quantitative ethnobotany and Amazonian conservation. Conserv Biol 8 (1): 225-248. DOI: 10.1046/j.1523-1739.1994.08010225.x.
Pholhiamhan R, Saensouk S, Saensouk P. 2018. Ethnobotany of Phu Thai ethnic group in Nakhon Phanom Province, Thailand. Walailak J Sci Technol 15 (10): 679-699. DOI: 10.48048/wjst.2018.3737.
Poopath M, Sookchaloem D, Santisuk T. 2012. The Dipterocarpaceae of Hala-Bala forest complex, Narathiwat and Yala Provinces, Peninsular Thailand. Thai For Bull (Bot) 40: 57-101.
Pornwanichphong A, Rittirod T. 2013. Guidelines for product development from bamboo to be a 5-star product of Ban Khan Kham Bamboo Product Occupation Development Group, Rai Noi Sub-district, Mueang Ubon Ratchathani District, Ubon Ratchathani Province. J Grad Stud Humanit Soc Sci 2 (2): 1-14.
Saensouk S, Boonma T, Saensouk P. 2021a. Six new species and a new record of *Curcuma* L. (Zingiberaceae) from Thailand. Biodiversitas 22 (4): 1658-1685. DOI: 10.13057/biodiv/d220410.
Saensouk S, Boonma T, Thomudtha A, Thomudtha P, Saensouk P. 2021b. *Curcuma wanenlueanga* (Zingiberaceae), a new species of subgenus *Curcuma* from Thailand. Biodiversitas 22 (7): 2988-2994. DOI: 10.13057/biodiv/d220752.
Saensouk S, Saensouk P, Pasorn P, Chantaranothai P. 2016. Diversity, traditional uses and new record of Zingiberaceae in Nam Nao National Park, Petchabun Province, Thailand. Agric Nat Resour 50: 445-453. DOI: 10.1016/j.anres.2016.08.002.
Saensouk S, Saensouk P. 2019. *Kaempferia mahasarakhamensis*, a new species from Thailand. Taiwania 64 (1): 39-42. DOI: 10.6165/tai.2019.64.39.
Saensouk S, Saensouk P. 2020. Comparative leaf surfaces of Orchidaceae species from Thailand. Suranaree J Sci Technol 27 (3): 030032(1-8).
Saisor N, Prathepha P, Saensouk S. 2021. Ethnobotanical study and utilization of plants in Khok Nhong Phok forest, Kosum Phisai District, Northeastern Thailand. Biodiversitas 22 (10): 4336-4348. DOI: 10.13057/biodiv/d221026.
Sharma YML. 1980. Bamboos in the Asia Pacific Region. Bamboo Research in Asia: Proceedings of a workshop held in Singapore, 28-30 May 1980. IDRC, Ottawa, ON, CA.
Sungkaew S, Hodkinson TR, Xia NH, Teerawatananon A. 2018. *Chimonocalamus auriculatus*, one more new temperate woody bamboo species of the genus (Poaceae: Bambusoideae: Arundinarieae) described from Thailand. Phytotaxa 357: 66-70. DOI: 10.11646/phytotaxa.357.1.7.
Sungkaew S, Suddee S, Wong MK, Teerawatananon A. 2021. *Thyrsostachys* (Poaceae: Bambusoideae) in Thailand: taxonomy, lectotypification and natural distribution. For Bull (Bot) 49 (1): 49-56. DOI: 10.20531/tfb.2021.49.1.05.
Sungkaew S, Teerawatananon A, Parnell ANJ, Dransfield S, Stapleton MAC, Hodkinson R T. 2007. *Dendrocalamus khoonmengii*, a new bamboo species (Poaceae: Bambusoideae) from peninsular Thailand. Thai For Bull (Bot) 35: 98-102.
Tamang DK, Dhakal D, Gurung S, Sharma NP, Shrestha DG. 2013. Bamboo diversity, distribution pattern and its uses in Sikkim (India) Himalaya. Intl J Sci Res Publ 3 (2): 1-6.
Teerawatananon A, Marod D, Hodkinson TR, Sungkaew S. 2017. *Chimonocalamus elegans*, a new temperate woody bamboo species (Poaceae: Bambusoideae) from Doi Phu Kha National Park, Thailand. Phytotaxa 302 (1): 97-100. DOI: 10.11646/phytotaxa.302.1.11.
Teerawatananon A, Sungkaew S, Marod D, Hodkinson TR. 2014. Studies in the recent new genus record *Pseudostachyum* (Poaceae: Bambusoideae) from Thailand: notes on its taxonomy, distribution and habitat. Nordic J Bot 32: 51-54. DOI: 10.1111/j.1756-1051.2012.01792.x.
Thailand. 2023. www.google.com/maps/place/Thailand/.
Thavorn R, Phetthongma R. 2014. The Thai way of life with bamboo; Local knowledge and management style. Asia-Pacific Regional Community Forestry Training Center. Bangkok.
Wong KM, Goh WL, Chokthaweepanich H, Clark LG, Sungkaew S, Widjaja EA, Xia NH. 2016. A subtribal classification of Malesian and Southwest Pacific woody bamboos (Poaceae: Bambusoideae: Bambuseae) informed by morphological and molecular studies. Sandakania 22: 1-36.
Yuming Y, Kanglin W, Shengji P, Jiming H. 2004. Bamboo diversity and traditional uses in Yunnan, China. Mt Res Dev 24 (2): 157-165. DOI: 10.1659/0276-4741(2004)024[0157:BDATUI]2.0.CO;2.