ລາວສະມາຊາຄົນສົມບິນຂອງການຍາກ ໃນການສຶກສາງເຊື່ອກາຍະວິພາກ ເຊິ່ງມີຄວາມແຕກຕ່າງກັນໃນແຕ່ລະເຂດພູມີພາກ ຂອງໄມ້ປ່ອງ້າຫຼາຍເຫຼົ່ານັ້ນ ເປັນການຍາກທີ່ຈະລະບຸເຖີງຊື່ຂອງຊະນິດໄມ້ປ່ອງໃນແຕ່ລະທ້ອງຖີ່ນ ວ່າຜະລິດຕະພັນຕ່າງໆເຫຼົ່ານັ້ນ ເຮັດມາຈາກໄມ້ປ່ອງຊະນິດໃດ ໃນການສຶກສານີ້ ມີການສຶກສາລັກສະນະດ້ານສັນຖານວິທະຍາ ແລະກາຍະວິພາກ ເພື່ອໃຊ້ເປັນຂໍ້ມູນຊ່ວຍໃນການລະບຸຊະນິດທີ່ຖືກນຳໃຊ້ເປັນຜະລິດຕະພັນຕ່າງໆຕົວຢ່າງ ຂອງໄມ້ປ່ອງທີ່ເກັບມາຈາກປ່າໃຊ້ເປັນຕົວແບບເພື່ອປຽບທຽບກັບຕົວຢ່າງແລະຈັງສືອະນາກົມວິທານຂອງໄມ້ປ່ອງ ທ່ານມີຢ່າງໃນຮູບແບບພະເສັດຄວາມພະຍາກອນ ເພື່ອກວດສອບລັກສະນະໂຄງສ້າງຂອງກຸ່ມທໍ່ລຳລຽງຈາກການສຶກສານີ້ ນອກຈາກຈະໃຊ້ພິສູດຊະນິດໃນຜະລິດຕະພັນຂອງໄມ້ປ່ອງແລ້ວຍັງສາມາດນຳໄປໃຊ້ໃນການຈັດການການນຳໃຊ້ການເກັບກູ້ແລະການສົ່ງເສີມການປູກໄມ້ປ່ອງນຳອີກ.

ຄຳສັບສຳຄັນ: ເລກສະມາຊາຄົນສົມບິນຂອງການຍາກ, ການຊະນິດ, ການສຶກສານ, ການສຶກສາແລະການຈັດການອັດດາການທິດສະພາ. 2

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Morphology and Anatomy of Bamboos Commonly Used in Lao PDR.

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Abstract

Bamboos have been closely associated with the livelihoods and traditions of Lao people for centuries. The products of bamboo can be used as materials or tools and differ region by region. The diversity of sources is sometimes reflected in confusion in the use of local names. Moreover, matching a product to the right species based on their raw material composition can be problematic. This study aimed to use a combination of morphological and anatomical procedures to identify the bamboos commonly used in Laos. Bamboo specimens were collected from the wild and the semi-processed product to provide material for studying their morphology and anatomy. These specimens were compared with herbarium specimens and taxonomic books were used. The anatomical structures were studied and described using the microscope. Ten species from six bamboo genera commonly used in Laos were found. They provide as young shoots for eating, culms for different types of tools, and cash income from culm handicrafts. Short morphological descriptions of these species are provided. The microscopic characteristic of the bamboos genera fall into three (out of four) types as: Type I (*Indosasa sinica*); while Type II was not found in this study; Type III (*Bambusa blumeana*, *B. polymorpha*, *B. tulda*, *Dendrocalamus membranaceus*, *Gigantochloa albociliata*, *Schizostachyum sp.*, *S. virgatum*, and *Thysrostachys siamensis*); and Type IV (*D. brandisii*). This study provides a potential reference source for the identification of bamboos in their products. The information can also be applied to tract if the protected species was used.

Key word: morphology, anatomy, bamboo, utilization

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Introduction

More than 80% of the population of Laos lives in rural areas, where the non-Timber Forest Products are usually used for food security. As bamboo is the most popular in this group of plants (non-Timber Forest Product), villagers collect this for a range of potential uses. The bamboo products differ region by region, reflecting the tradition of tribes, cultures and societies within Laos. The diversity of sources is sometimes reflected in confusion in the use of local names. The current problem is mainly one after processing, when it can be very difficult to identify the raw materials which have been used for the manufacture of different products. Laos has many bamboo shoots that are regarded as having good flavors, including Indosasa sinica are sold locally for US$ 0.15-0.3 per kg. The culms provide many different uses, including house construction, baskets, baskets for steaming sticky rice, cages, sticky rice containers, chopsticks, toothpicks, traditional music instruments etc. The culm of *Dendrocalamus membranaceus* (5-7 m long, 10-12 cm in diameters) are sold locally for US$ 0.4-0.8. Domestic markets, as well as export markets have the potential to help in maintaining the continuous traditional production of these items throughout the year.

A range of studies spanning centuries have been done on the morphology and anatomy of bamboo, from Gamble (1896); McClure (1966); Liese (1985); Ketphanh et al. (1994); Dransfield and Widjaja (1995); Wong (1995); Liese (1998); Liese and Grosser (2000); Wong (2004); Li et al. (2006); to Sungkaew (2008). All studies concluded that it was important to study the characteristics of bamboo in the natural setting the problem over the confusion of the local names is to be corrected.

This thesis project was aimed at studying the problems of correct classification of local bamboo through the combined use of morphological and anatomical approaches; 1) study the morphology and anatomy of bamboo culm; 2) make use of culm anatomy for identification of raw materials in finished products. It was hoped that the results from this study will be used to provide standards for species identification in bamboo products. Further, it is anticipated that the information generated will be potentially useful for identifying the species used in finished items based on the use of illegal or prohibited materials.

Materials and Methods

In order to gain as much information as possible on the commonly used bamboos in Laos, visits were made to local markets, to check for products made from bamboos. Collections of specimens from the natural habitats of the bamboos, using classical herbarium techniques, were also undertaken for comparison with the samples being processed. Information collected during the sampling process included local names, the part used, collecting period, location, etc. Each specimen set should include samples of leaves, flowers and
fruits (if possible). If flowers and fruits samples are not available, other important vegetative parts can be useful for species identification; including culm sheaths, branch components, and particularly flying shoots which are useful for species identification as suggested by Sungkaew (2008).

The species descriptions have been based on herbarium specimens, current records, and on living plants, supplemented by observations of plants made in the field. However, the characteristics of the reproductive parts were based mainly on specimen examination herbarium techniques, at The Forest Herbarium, Department of National Parks, Wildlife and Plant Conservation, Bangkok, Thailand (BKF); The Forest Biology Department, Faculty of Forestry, Kasetsart University, Thailand (KUFF).

The anatomy of bamboo was studied on microscopic permanent slide according to methods outlined by Siripatanadilok (1986). The vascular bundles were determined by measuring the number of vascular bundle (metavessel, phloem, protovessel, sclerenchyma sheath; fiber strand, lumen, parenchyma, and ground tissue). Pictures of some representative characteristics were taken using the photomicroscope.

**Results and Discussion**

Based on morphological information, ten species from six genera of the bamboos were identified. However, a species of *Schizostachyum* was not identified at the species level, due to the lack of reproductive parts (flowers and fruits). Due to the difficulties in preparing scientific specimens, some collected specimens did not have enough information to be identified. The diversity of sources is sometimes reflected in the confusion in the use of local names.

It is not necessary for vascular bundles of the same bamboo genera to be in the same type such as *Dendrocalamus brandisii* in Type IV, but *D. membranaceus* belongs to Type III. On other hand, vascular bundles from different genera can fall into the same type as: found in three species of *Bambusa* (*B. blumeana*, *B. polymorpha*, *B. tulda*), one species of *Dendrocalamus* (*D. membranaceus*), one species of *Gigantochloa* (*G. albociliata*), two species of *Schizostachyum* (*Schizostachyum sp.*, *S. virgatum*), and one species of *Thyrsostachys* (*T. siamensis*), all fall into the same type, Type III. Therefore, additional anatomical characteristics include metavessels, phloem, protovessel, sclerenchyma sheaths, fiber strand(s), parenchyma and bundles charactering the bamboo culm are necessary to identify at the species level. In the species descriptions that follow the taxa are arranged alphabetically.

**Morphology**

1. *Bambusa blumeana* Schultes: Vernacular name: Mai phai banh

   Culms straight, densely tufted, 12-18 m high, ca. 10-15 cm in diameter (mid-culm portion); internodes 20-35 cm long;
walls 1.5-2 cm thick; nodes prominent, lower ones with a ring of aerial roots. Culm-sheaths tardily deciduous, 32-35 cm long, 22-24 cm wide, covered with densely stiffly brown hairs; auricles reflexed, covered with dark brown hairs; ligule stiff, the middle tallest and fringed; blade narrowly linear-lanceolate, erect in basal node(s), margin incurved. Branches on lower nodes armed with short recurved spines. Leaf-blades linear-lanceolate, 12-17 cm long, 1.5-2.5 cm wide; auricles small, bearing stiff hairs; ligule truncate. Inflorescences consisted of pseudospikelets, 1-5 cm long. Spikelets pale purple-green, linear, 2-4 cm long, 0.2-0.4 cm wide; florets 5-12; glumes 1-2; lemma ovate-oblong, 6-8 mm long, 2-4 mm wide, 9-10-veined, margins glabrous, apex acute; palea ca. 6 mm long, 1.5 mm wide, 3-veined between and 3-veined on either side of keels.

Notes: This species can be found in both mixed forest and deciduous forests. The culms can be used for house construction, baskets, cages, etc.

2. **Bambusa polymorpha** Munro: Vernacular name: Mai poung

Culms straight, densely tufted, 15-18 m high, ca. 10-12 cm in diameter (mid-culm portion); internodes 40-60 cm long; walls 1.2-1.5 cm thick; nodes prominent. Culm-sheaths deciduous, 18-19 cm long, 21-25 cm wide, covered with densely stiffly dark brown hairs; auricles long ciliate, when young embracing the culm; ligule irregularly dentate, ciliate; blade ovate-triangular, erect, covered with deciduous hairs. Branches curved and densely interwoven. Leaf-blades linear-lanceolate, 20-28 cm long, 3-4.5 cm wide, usually covered with hairs, margins scabrous; auricles small, ciliate; ligule short, irregularly. Inflorescences consisted of pseudospikelet brownish, enclosed in a long curved glabrous bracts. Spikelets embraced by sheathlike bracts 1-1.5 cm long, glossy; florets 2 or 3, apical one sterile; rachilla segments flat, glabrous; glumes 3, ovate, apex mucronate; lemma ovate, many veined, apex mucronate; palea lanceolate, about as long as or slightly longer than lemma, keels glabrous, apex acute; lodicules 3, 3-5 veined, margins ciliolate.

Notes: This species can be found in the mixed, deciduous, and evergreen forests. The culms can be used for trays, sticky rice containers, etc.

3. **Bambusa tulda** Roxb: Vernacular name: Mai bong

Culms usually bend, loosely tufted, 10-12 m high, ca. 3-5 cm in diameter (mid-culm portion); internodes 30-35 cm long; walls 1.2-1.5 cm thick, with scurfy when young; nodes lower ones with aerial roots. Culm-sheaths tardily deciduous, coriaceous, 13-15 cm long, 16-17 cm wide, often covered with appressed brown hairs; auricles large, unequal continuous with the blade, margins ciliate; ligule narrow, entire, minutely ciliolate; blade broadly triangular, coriaceous, erect. Leaf-blades linear-lanceolate to oblong, 17-18 cm long, 1.5-2.5 cm wide, covered with hairs,
puberulent; auricles fringed with long white hairs; ligule very small. Inflorescences consisted of pseudospikelets, 2-5 cm long, supported by chaffy bracts. Spikelets pale purple-green, linear, 2-3 cm long, 0.3-0.4 cm wide; florets 4-10, central 2-5 perfect; glumes 2; lemma ovate-oblong, 5-7 mm long, 2-3 mm wide, glabrous, 8-10-veined, margins glabrous, apex acute; palea ca. 5 mm long, 1.5 mm wide, 3-veined between, 3-veined.

Notes: This species can be found in hills, mixed forests and along watercourses. The shoots are edible. The culms can be used for sticky rice containers, fishing tools, etc.

4. *Dendrocalamus brandisii* (Munro) Kurz: Vernacular name: Mai hok

Culms erect with pendulous tip, loosely tufted, 18-25 m high, ca. 13-17 cm in diameter (mid-culm portion); internodes 30-40 cm long; walls 1.3-2.4 cm thick; nodes slightly swelled, lower ones with aerial roots. Culm-sheaths deciduous, 32-35 cm long, 21-22 cm wide, early deciduous, covered with brown hairs; auricles readily deciduous; ligule continuous with the sheath top, margin broadly lacerate; blade lanceolate, reflexed, sometime erect, adaxial base densely hairy. Leaf-blades oblong-lanceolate, 22-30 cm long, 3-5 cm wide; auricles absent or as inconspicuous ridges; ligule margin dentate to sub-entire at the middle, lacerate outwards. Inflorescences consisted of pseudospikelets 5-20 per node. Spikelets ovate-orbicular, 6-9 mm long, 3-5 mm wide; florets 2-4; glumes 1 or 2, apex acute; lemma 5-6 mm long; palea 2-keeled, ciliate, 3-veined between keels.

Notes: This species can be found in dry evergreen and evergreen forests. The shoots are popular for eating. The culms can be used for house constructions, cages, etc.

5. *Dendrocalamus membranaceus* Munro: Vernacular name: Mai sang

Culms erect, loosely tufted, 20-25 m high, ca. 10-15 cm in diameter (mid-culm portion); internodes 30-45 cm long; walls relatively thin, about 1.1-2 cm thick, when young covered with white powdery deciduous scurf; nodes prominent. Culm-sheaths deciduous, 38-40 cm long, 17-18 cm wide, covered with dark brown to black hairs; auricles wavy or pleated, margins fringed with bristles; ligule margin divided into broad lacerations; blade linear-lanceolate, reflexed, and covered with brown hairs. Leaf-blades linear, 12-13 cm long, 1.2-2 cm wide, thin, hispid above; auricles falcate lobes, purplish ciliate; ligule very short, margin lacerate. Inflorescences consisted of pseudospikelet slightly compressed. Spikelets glabrous; fertile florets 2-5; glumes 2 or more; lemma 9-11 mm long, apex long mucronate; palea 6-7 mm long.

Notes: This species can be found in mixed, and deciduous forests, and at the base of hills. The culms can be used for cottages, toothpicks, chopsticks, sticks for roasting meat and vegetables, baskets, chicken and cages. The shoots are edible.
6. *Gigantochloa albociliata* (Munro)
*Kurz*: Vernacular name: Mai lai

Culms elongate arcuate-decurved, densely tufted, 8-13 m high, ca. 2-4 cm in diameter (mid-culm portion); internodes 25-30 cm long; walls 1-1.5 cm thick; nodes prominent. Culm-sheaths folded and coriaceous, 12-14 cm long, 7-10 cm wide, apex truncate and narrow, covered with dense dark hairs; auricles small; ligule margin divided into broad lacerations; blade obleng-lanceolate, reflexed, acuminate. Branches almost as strong as culm. Leaf-blades linear-lanceolate, 18-19 cm long, 2-5 cm wide, apex sublate-acuminate; ligule long, hairy; margin irregularly; auricles indistinct. Inflorescences consisted of pseudospikelets at each node, white ciliate bracts. Spikelets elongate-linear, curved, and rarely straight, 1.5-2.3 cm long; florets 1 or 2; glumes 2 or 3, ovate; lemma margins white ciliate; palea shorter than lemma.

Notes: This species can be found in mixed forests, and along the river bank. The shoots are popular for eating. The culms can be used for fishing tools, small sticky rice containers, etc.

7. *Indosasa sinica* C.D. Chou and C.S. Chao: Vernacular name: Noh khome

Culms straight, 8-12 m high, ca. 3-5 cm in diameter (mid-culm portion); internodes 22-30 cm long, flexuose; walls 0.7-1.2 cm thick; nodes very prominent. Culm-sheaths tardily deciduous, coriaceous, 19-20 cm long, 9-10 cm wide, covered with densely stilly brown hairs; auricles usually reflexed, deciduous dark brown hairs; ligule early deciduous; blade narrowly lanceolate, erect in basal and apical sheaths, margin incurved. Leaf-blades linear-lanceolate, 10-15 cm long, 3-4 cm wide, usually hairy both side, margins scabrous; sheath striate; auricles small, bearing a few bristles; ligule truncate, fimbriate; margin irregularly dentate to lacerate. Inflorescences consisted of pseudospikelets, rachilla articulate, glabrous; lemma 1.2-1.5 cm long, glaucous, glabrous; palea shorter than lemma; lodicules membranous.

Notes: This species can be found in evergreen and dry evergreen forests. The shoots are popular for eating.

8. *Schizostachyum* sp.: Vernacular name: Mai sod

Culms erect with long pendulous, densely tufted, 7-12 m high, ca. 2-6 cm in diameter (mid-culm portion); internodes 35-45 cm long, covered with white hairs; walls 0.5-0.8 cm thick; nodes not prominent, oblique. Culm-sheaths hard, 13-14 cm long, 11-12 cm wide, covered by black and pale yellow hairs; auricles tiny or absent; ligule tiny; blade narrowly, linear-lanceolate, tapering, densely hairs. Leaf-blades linear-lanceolate, 20-25 cm long, 2-4 cm wide, could be either glabrous; auricles small but prominent; ligule short. Inflorescences unknown.

Notes: This species can be found in mixed forests, flat land, and deforested areas. The culms can be used for mats (wall), baskets, bloom grass handles, traditional music instrument, etc.
9. *Schizostachyum virgatum* (Munro) H.B Naithani and Bennet: Vernacular name: Mai hia

Culms straight with long pendulous, loosely tufted, 8-12 m high, ca. 2-4 cm in diameter (mid-culm portion); internodes 30-40 cm long, covered with appressed white hairs initially, glabrous later; walls 0.4-1 cm thick; nodes not prominent. Culm-sheaths hard, gather up, outside covered with dark-brown hairs, 23-24 cm long, 9-10 cm wide, margins revolute, covered with short rigid hairs; auricles bristle; ligule irregularly dentate, bristles; blades narrowly lanceolate, tapering, usually erect, covered with densely hairs. Leaf-blades linear-lanceolate, acuminate; 30-35 cm long, 3-4 cm wide; auricles small with bristles; ligule short. Inflorescences consisted of densely tufted of pseudospikelets at the nodes. Spikelets 15-17 mm long without a rachilla, only one perfect floret.

Notes: This species can be found in mixed, deciduous, and dry evergreen forests, and along the river bank. The culms can be used for mats (panel), traditional music instrument, etc.


Culms straight with arching tip densely tufted, 10-15 m high, ca. 3-5 cm in diameter (mid-culm portion), smooth, grayish-green, covered with culm sheaths; internodes 25-30 cm long thick bearing a white ring below the nodes; walls very thick, about 2-2.5 cm; nodes not prominent. Culm-sheaths tardy deciduous, narrowly, 25-28 cm long, 8-10 cm wide, pale to purplish-green turning and thin with age, covered with scattered hairs; auricles absent; ligule very short; blade narrowly-lanceolate, erected. Leaf-blades narrowly, linear, 8-9 cm long, 0.8-1 cm wide, thin, secondary veins 3-5, hispid above, margins scabrous; sheath striate, cleft nearly to the base; auricles absent, purplish ciliate; ligule very short, ciliate, margin irregularly dentate to lacerate. Inflorescences consisted of a few pseudospikelets. Spikelets 1.2-1.4 cm long; gemmiferous bracts 2 or 3; glumes 2 or 3; fertile florets 1-3, lemma 1-1.5 cm long; palea slightly longer than lemma.

Notes: This species can be found in mixed and deciduous forests. The shoots are edible. The culms can be used for bamboo beds, tool handles, etc.

**Anatomy**

1. *Bambusa blumeana* Schultes

Vascular bundles sectioned at the middle of culm internodes were Type III. Each vascular bundle consisted of four discrete bundles. Two large round shaped metavessels were about 240-265 μm wide. One phloem strand was located between two metavessels on the upper level. One small protovessel lacuna about 32-40 μm wide, was located between two metavessels on the lower level. Sclerenchyma sheaths (fiber) were C-shaped bundles of thick wall fiber cells attached to the exterior part of the metavessels, phloem, and protovessel. Fiber strands inside the culm wall appeared
close to the protovessel at the lower level were composed of two, cell types, small thick wall fiber cells with small lumens on the outside and larger size but thin wall fiber cells with larger lumens inside the strand. The strand is elliptic to kidney shape embedded in the thick wall rounded to elliptic shape parenchymatous ground tissue.

2. **Bambusa polymorpha** Munro

Vascular bundles sectioned at the middle of culm internodes were type III. Each vascular bundle consisted of four discrete bundles. Two large round shaped metavessels were about 212-228 μm wide. One phloem strand was located between two metavessels on the upper level. One small protovessel lacuna, about 18-26 μm wide, was located between two metavessels on the lower level. Sclerenchyma sheaths (fiber) were C-shaped bundles of thick wall fiber cells attached to exterior part of the metavessels, phloem, and protovessel. Fiber strand inside the culm wall appeared close to the protovessel at the lower level is a bean seed shape. It were composed of two cell types, a clump of small size thick wall fiber cells with small lumens at both end, and remain is larger size but thin wall fiber with larger lumens the strand. The strand is elliptic to kidney shape embedded in the thin wall oval to elliptic shape parenchymatous ground tissue.

3. **Bambusa tulda** Roxb.

Vascular bundles sectioned at the middle of culm internodes were the type III. Its vascular bundles similar to *B. blumeana*. Each vascular bundle consisted of four discrete bundles. Two large round shaped metavessels were about 174-185 μm wide. One phloem strand was located between two metavessels on the upper level. One small protovessel lacuna, about 30-38 μm wide, located between two metavessels on the lower level. Sclerenchyma sheaths (fiber) were C-shaped bundles of thick wall fiber cells attached to exterior part of the metavessels, phloem, and protovessel. Fiber strand inside the culm wall appeared close to the protovessel at the lower level were composed of two cell types, small very thick wall fiber cells with very small lumens on the outside and larger size with thin wall fiber cells and larger lumens inside the strand. The strand is elliptic to oval shape embedded in the thick wall rounded to elliptic shape parenchymatous ground tissue.

4. **Dendrocalamus brandisii** (Munro) Kurz

Vascular bundles sectioned at the middle of culm internodes were type IV. Each vascular bundle consisted of four discrete bundles. Two large round shaped metavessels were about 120-135 μm wide. One phloem strand was located between two metavessels on the upper level. One small protovessel lacuna, about 26-34 μm wide, was located between two metavessels on the lower level. Sclerenchyma sheaths (fiber) were thin C-shaped bundles of thick wall fiber cells attached to the exterior part of the metavessels, phloem, and protovessel. The thicker of the sheath at metavessel, and phloem are similar. Two
small vessels found between phloem and protovessel. At the inner part of culm wall two fiber strands are kidney shape embedded in the thin wall elliptic to rounded shape parenchymatous ground tissue, the fiber strand at the phloem side is smaller than at the protovessel side. Fiber cells of the strand have thicker at periphery and thinner walls in the inner core.

5. **Dendrocalamus membranaceus**
(Munro)

Vascular bundles sectioned at the middle of culm internodes were the type III. Each vascular bundle consisted of four discrete bundles. Two large round shaped metavessels were about 162-178 μm wide. One phloem strand was located between two metavessels on the upper level. One small protovessel lacuna, about 10-22 μm wide, was located between two metavessels on the exterior level. Sclerenchyma sheaths (fiber) were bundle comprises of two types of cells, small size thick wall fiber cells with small lumens are inside and larger size but thin wall fiber with larger lumens are outside, the sheath at the phloem is thicker than the others. Two small vessels found between phloem and protovessel. Fiber strands at the inner part of culm wall appeared close to the protovessel at the lower level composed of large size very thin wall fiber cells. The strand is heart shape embedded in the thin wall elliptic to oval shape parenchymatous ground tissue.

6. **Gigantochloa albociliata** (Munro) Kurz

Vascular bundles sectioned at the middle of culm internodes were the type III. Each vascular bundle consisted of four discrete bundles. Two large round shaped metavessels were about 164-176 μm wide. One phloem strand was located between two metavessels on the upper level. One small protovessel lacuna, about 21-30 μm wide, was located between two metavessels on the lower level. Sclerenchyma sheaths (fiber) were C-shaped bundles of thick wall fiber cells attached to the exterior part of the metavessels, phloem, and protovessel. The sheath is similar thick or a little thicker at the phloem. Fiber strand inside the culm wall appeared close to the protovessel at the lower level composed of large size and thin wall cells. The strand is a heart to half round shape embedded in the thick wall oval to rounded shape parenchymatous ground tissue.

7. **Indosasa sinica** C.D. Chou and C.S. Chao

Vascular bundles sectioned at the middle of culm internodes were the type I. Each vascular bundle consisted of four discrete bundles. Two large round shaped metavessels were about 105-117 μm wide. One phloem strand was located between two metavessels on the upper level. One small protovessel lacuna, about 24-36 μm wide, was located between two metavessels on the lower level. Sclerenchyma sheaths (fiber) were thick C-shaped bundles. They were composed of two types of cells, small size has very thick wall fiber cells.
with very small lumens as a layer inside and larger size has thin wall fiber cells with larger lumens on outside layer at the sheath. Ground tissue is large round thin wall irregular size parenchymatous calls.

8. *Schizostachyum* sp.

Vascular bundles sectioned at the middle of culm internodes were the type III. Each vascular bundle consisted of four discrete bundles. Two large round shaped metavessels were about 121-132 μm wide. One phloem strand was located between two metavessels on the upper level. One small protovessel lacuna, about 32-46 μm wide, was located between two metavessels on the lower level. Sclerenchyma sheaths (fiber) compose of very thick wall fiber cells attached to the exterior part of the metavessels, phloem, and protovessel. Only at the phloem sheath is thicker and composes of two layers where the outer layer is large size and thinner wall fiber. Fiber strand inside the culm wall appeared close to the protovessel at the lower level were composed of large size thin wall fiber cells. The strand is high heart shape embedded in the thin wall elliptic to oval shape parenchymatous ground tissue.

9. *Schizostachyum virgatum* (Munro) H.B Naithani and Bennet

Vascular bundles sectioned at the middle of culm internodes were the type III. Each vascular bundle consisted of four discrete bundles. Two large round shaped metavessels were about 132-148 μm wide. One phloem strand was located between two metavessels on the upper level. One small protovessel lacuna, about 35-44 μm wide, was located between two metavessels on the lower level. Sclerenchyma sheaths (fiber) were thick and thicker at the metavessels. They composes of two types cells, a thin layer of small size very thick wall fiber cells with small lumens at inside and a thick layer of larger size but thin wall fiber cells with larger lumens outside the sheath. Fiber strand is narrow elliptical shape sometimes appeared close to the sheath of protovessel cause missing identification of the vascular bundles type. The strand composes of thin wall fiber similar to the outside layer of the sheath.

10. *Thrysostachys siamensis* Gamble

Vascular bundles sectioned at the middle of culm internodes were the type III. Each vascular bundle consisted of four discrete bundles. Two large round shape metavessels were about 182-198 μm wide. One phloem strand was located between two metavessels on the upper level. One small protovessel lacuna, about 25-34 μm wide, was located between two metavessels on the lower level. Two small vascular between phloem and protovessel. Sclerenchyma sheaths (fiber) were very thick wall fiber cells attached to the exterior part of the metavessels, phloem, and protovessel. The sheath on the phloem was thicker than the others. Fiber strand inside the culm wall appeared close to the protovessel at the lower level composes of large size very thick wall fiber cells. The strand is high heart shape embedded in the thin wall elliptic to oval shape parenchymatous ground tissue.
Conclusions and Recommendations

Morphological and anatomical descriptions, together with their utilization of bamboos commonly used in Laos have been presented in this paper. Ten species from six genera of the bamboos have been taxonomically identified. The anatomical characteristics of all samples show consistency in types of vascular bundles that can be used as standards for the identification of bamboos commonly used in Laos. It can be also be used for the matching of products with the raw materials. The bamboos culms cross-section fall into three types, out of four, described by Wong (1995) as follows: Type I is found in Indosasa sinica; the Type II was not found in this study; Type III is found in Bambusa blumeana, B. polymorpha, B. tulda, Dendrocalamus membranaceus, Gigantochloa albociliata, Schizostachyum sp., S. virgatum, and Thyrsostachys siamensis; and Type IV is found in Dendrocalamus brandisii.

Most Lao people prefer to eat bamboo shoots, the popular species are Mai lai (G. albociliata), Mai hok (D. brandisii), Mai hauk (T. siamensis). These are sold in all regions; Noh khome (Indosasa sinica) only occurring in the northern region. They are sold in local markets at prices US$ 0.15-0.3 per kg. Bamboo culms provide materials for many different products (chopsticks, toothpicks) as Mai sang (D. membranaceus) the length of 7 m long, 8-12 cm in diameter are sold in local markets in the central region at prices US$ 0.5-0.6. A mat (panel, size 3x2 m) of Mai hia (S. virgatum) is sold locally at prices US$ 1.15-1.5. Other culm products from Mai phai banh (B. blumeana), Mai poung (B. polymorpha), Mai bong (B. tulda) provide material for house construction, bamboo beds, bamboo stairs, cages, baskets, trays, bamboo strips, lams, cradles, sticky rice containers, etc., and their shoots are edible; Mai sod (Schizostachyum sp.) provides material for traditional musical instruments (Khêne and flute), mats (wall). These products can be found in all regions throughout Laos.

The government of Laos, especially the Department of Forestry, should focus on providing technical and marketing assistance through surveying and reporting on the availability, status, and use of bamboo resources. Forestry offices should provide training programs for villagers on techniques of production, development and improvement, relating to bamboos, as well as the sustainable management of these resources.

Literature Cited


Siripatanadilok, S. 1986. Plant Anatomy. Forest Biological Science Department, Forestry Faculty, Kasetsart University, Bangkok, Thailand. (in Thai)


Picture 1a Some bamboos commonly used in Lao PDR: 1=Clump habit of *Bambusa blumeana*; 2=Shoot of *B. polymorpha*; 3=Shoot of *B. tulda*; 4=Shoots of *Dendrocalamus brandisii*; 5=Culms and clump habit of *D. membranaceus*;
Picture 1b Some bamboos commonly used in Lao PDR: 6=Shoot of G. albociliata; 7=Shoots of Indosasa sinica; 8=Culm sheath of Schizostachyum virgatum; 9=Culm sheath of Schizostachyum sp.; 10=Clump habit of Thyrsostachys siamensis.
Picture 2a Vascular bundles of bamboo culm:
1 = *Bambusa blumeana*;
2 = *B. polymorpha*;
3 = *B. tulda*;
4 = *Dendrocalamus brandisii*;
5 = *D. membranaceus*;
Picture 2b Vascular bundles of bamboo culm:
6 = Thyrsostachys siamensis
7 = G. albociliata;
8 = Indosasa sinica;
9 = Schizostachyum virgatum;
10 = Schizostachyum sp.