

**MINISTRY OF EDUCATION  
AND TRAINING**

**VIETNAM ACADEMY OF  
SCIENCE AND TECHNOLOGY**

**GRADUATE UNIVERSITY OF SCIENCE AND TECHNOLOGY**



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**RESEARCH ON THE DIVERSITY OF THE BAMBUSOIDEAE  
IN THE CENTRAL HIGHLANDS**

**SUMMARY OF ECOLOGICAL PHD THESIS**

**Code: 9 42 01 20**

**LAM DONG - 2024**

The dissertation is completed at: Graduate University of Science and Technology, Vietnam Academy Science and Technology

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The dissertation is examined by Examination Board of Graduate University of Science and Technology, Vietnam Academy of Science and Technology at..... (time, date.....)

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## INTRODUCTION

### 1. The urgency of the dissertation

The Central Highlands has an area of about 54.7 thousand square kilometers, has very diverse natural conditions in terrain as well as climate types, so different types of vegetation: closed evergreen tropical rain forests, closed evergreen tropical rain forest on lowland, dry dipterocarp forest, highland cold forest. Therefore, the Central Highlands is considered one of the centers of plant species diversity in Vietnam in general and bamboo in particular.

In recent years, many new species of bamboo have been discovered in the Central Highlands. This proves the huge species diversity of the Bambusoideae in this area. However, currently in the Central Highlands there is no comprehensive research on the following aspects: (1) morphological characteristics, (2) classification system, (3) distribution of bamboo. Therefore, the project "Research on the diversity of the Bambusoideae in the Central Highlands" is necessary, in order to solve the above problems both theoretically and practically. The results of the project will contribute to building a scientific database on morphology to help identify classification levels, thereby orienting the use value of bamboo. The database on a variety of classification will be an important source of information to confirm resources for Vietnam in general and the Central Highlands in particular. In addition, research on the distribution of bamboo in the Central Highlands will be the basis for further research on conservation, construction, and strategic planning for the development of this non-timber forest product resource, while contributing to enhance the use value of bamboo species in the Central Highlands.

### 2. Objectives

Assess the morphological diversity, species composition and distribution of the Bambusoideae in the Central Highlands.

### **3. The main research contents of the thesis**

- Research on morphological diversity of Bambusoideae in the Central Highlands.

- Research classification system of Bambusoideae in the Central Highlands.

- Research on the distribution of Bambusoideae in the Central Highlands.

### **4. Scientific and practical basis of the thesis**

- Scientific significance: The study contributes to supplementing and completing the diversity of the Bambusoideae in the Central Highlands about morphology, classification and distribution.

- Practice of the project: The thesis has proposed a key to tribes, subtribes, genera, and species for bamboo species; described 02 new species (*Chimonocalamus bidouppensis* N.H. Nghia & V.T. Tran; *Yersinochloa nghiana* V.T. Tran & T.V. Tran); provides data on the distribution of the Bambusoideae in the Central Highlands. The research results of the project are the scientific basis for further research on biology, ecology as well as the development and use of bamboo resources in the Central Highlands region.

### **5. New contributions of the thesis**

1. Describe two new species: (1) *Chimonocalamus bidouppensis* N.H. Nghia & V.T. Tran; (2) *Yersinochloa nghiana* V.T. Tran & T.V. Tran.

2. Provides morphological data (vegetative organs and reproductive in plants) of the Bambusoideae in the Central Highlands, including data on morphological characteristics of subfamily, tribe, subtribe, genus, and

species. Building a key to tribes, subtribes, genera, and species of the Bambusoideae in the Central Highlands.

3. Provides data on the distribution (geographical region, altitude and vegetation type) of Bambusoideae in the Central Highlands.

## **CHAPTER 1. LITERATURE REVIEW**

### **1.1. Research of the Bambusoideae classification system in the world**

#### **1.1.1. Classification of the Bambusoideae based on morphological characteristics**

In the world: In the period before 1995, research only focused on the characteristics of the reproductive organs of flowers and fruits. However, bamboo often has a long and indeterminate flowering period, making fruit collection difficult, and some genera often have similarities in terms of the detailed structure of the reproductive organs. Therefore, relying only on reproductive organs can lead to confusion in species identification.

+ At the current stage: Besides the characteristics of flower and fruit, vegetative organ characteristics such as life form, branching characteristics, and shoots have been added as important morphological characteristics for consideration and comparison differences at genus and species levels. These morphological characteristics are also valuable in genus and species identification. Because these are characteristics that are easy to recognize and easier to compare than the reproductive organs, because the flowering and fruiting time of bamboo is often long and difficult to determine.

Through an overview of research on the classification system, we find that combining morphological characteristics of vegetative and reproductive organs is necessary in the process of identifying taxonomic of the Bambusoideae.

#### **1.1.2. Classification of Bambusoideae based on molecular biology**

Molecular biological techniques can be used in species identification and phylogenetic relationships among groups, including genera and species. Molecular biology research on the world mainly focuses on certain groups or genera and species. However, most authors agree to divide the Bambusoideae into three tribes: Arundinarieae, Bambuseae and Olyreae. This coincides with studies on the Bambusoideae classification based on morphological characteristics.

### **1.2. Research distribution of Bambusoideae**

The Bambusoideae has a wide distribution, present on most continents and distributed in many different habitats. Species of the tribe Arundinarieae are usually distributed in mountainous areas with altitudes above 1,500 m, and species of the tribe Bambuseae are usually distributed at altitudes below 1,500 m.

### **1.3. Bamboo research situation in Vietnam**

In Vietnam, several authors have studied the taxonomy of the Bambusoideae such as Camus and Camus (1923), Pham Hoang Ho (2000), Nguyen Hoang Nghia (2006).

From the referenced sources, we find that the species composition of the Bambusoideae recorded in Vietnam is not consistent among the authors. In addition, research only focuses on statistical species composition and new species, but there has not been any complete research on the morphology, taxonomic and distribution of the Bambusoideae.

The Central Highlands has a special location in terms of geography, topography and vegetation type, creating a diversity of plants in general and bamboo in particular. In recent years, many bamboo species have been discovered at new taxonomic levels (genus, species) in the Central Highlands. Besides, in the period before 2005, studies only reported on

species composition. Since 2006, after statistics, Nguyen Hoang Nghia said that there are many species in the Central Highlands that have not been identified, because data on morphological characteristics, especially flowers, are lacking to identify species. This is considered is a basis for the topic in further research to supplement missing data in identifying and adding new species to the flora of the Central Highlands in particular and Vietnam in general.

#### **1.4. Natural conditions of the Central Highlands**

The Central Highlands includes 5 provinces of Kon Tum, Gia Lai, Dak Lak, Dak Nong, Lam Dong with an area of nearly 5.4 million hectares (equivalent to 1/6 of the country's area), with gradually longer borders with Laos and Cambodia. This is a unique tropical highland mountain eco-geographical region in the South of Truong Son, rich in potential for socio-economic development, and has a special position in terms of natural, economic - political, and national military aspects. environmental protection and security for Vietnam.

## **CHAPTER 2. RESEARCH OBJECTS AND METHODS**

### **2.1. Research objects**

#### **2.1.1. Research objects**

Species of the Bambusoideae in the Central Highlands.

#### **2.1.2. Research time**

The study was conducted from January 2021 to July 2023.

#### **2.1.3. Research location**

Lam Dong provine: Bidoup – Nui Ba National Park, Lanh Hanh, Braian, Bao Loc pass, B40 Pass

Kon Tum provine: Lo Xo pass, Ngoc Linh mountain, Ngoc Hoi area

Gia Lai provine: Plateau Kon Ha Nung, Le Thanh, Ialy

Dak Lak provine: dry dipterocarp forest (Ea Sup, Buon Don)

Dak Nong provine: Ta Dung

## **2.2. Research Methods**

### **2.2.1. Specimens and research materials**

- The thesis inherits a number of relevant documents and specimens about bamboo in Vietnam and the World.

### **2.2.2. Methods of investigation, collection and processing of specimens**

#### ***Methods of plant investigation***

- Research tools:

+ Sample collection tools: Lattice clips, newspaper, branch cutting scissors...

+ Information documentation tools: Etiket, notebook, camera, GPS...

- Establishing investigation routes: Research and establish a number of investigation routes based on previous research documents.

Select transects to collect samples according to Nguyen Nghia Thin (2008), Thai Van Trung (1999)

#### ***Sample collection method***

The parts of bamboo that need to be sampled include: flowers, fruits, culm sheath (from the 7th to 10th node from the base upwards), branches and leaves, nodes and internodes, and rhizomes. Each species collected 5-7 samples. The collected samples are guaranteed to be free of pests and diseases and are highly representative of the sample.

Bamboo flowers and fruits need to be placed in a Polyethylene bag to keep the sample for observation on a stereo microscope. After being collected, the sample is immediately pressed and full information is recorded.

#### ***Sample handling***



Samples were pressed into 40 x 60 cm sized papers. Each lattice clamp holds approximately 20 specimens.

Samples were dried in a Memmert oven at a temperature of 60oC for 3 - 5 days. The dried samples are put on paper as specimens. The dried specimens are preserved at the plant herbarium of the Taynguyen Institute of Scientific Research.

### ***Observe the specimen***

Specimens were observed with the eye and a magnifying glass. Flower and fruit samples were observed under an Ermecon stereo microscope (Germany) attached to a Canon EOS 600D digital camera.

### **2.2.3. Method of classifying plants**

#### ***Plant identification***

Identify species by morphological comparison method, the present study is based on specimens kept in the following herbaria in Vietnam and on the world.

#### ***Method for constructing classification keys***

Build a dichotomous classification key by selecting dominant and opposing characteristics to distinguish species in the Bambosoideae.

#### ***Describe plants***

Based on the classification system, taxa are described in turn as follows:

- Scientific name, year of publication.
- Vietnamese name
- Basionym.
- Synonym.
- Research sample.

- The next characteristics that need to be described for bamboo are underground stems, aerial stems, branching characteristics, color, size and valuable characteristics in identification of shoots, leaves, inflorescences, fruit.

- Ecology and distribution.

- Uses.

#### **2.2.4. Distribution research methods**

Using a Garmin GPS78 locator, record altitude and coordinates at the sample collection area.

Use QGIS software to build species distribution maps. Sử dụng phần mềm QGIS để xây dựng bản đồ phân bố loài.

Record vegetation types with distribution of species of the Bambusoideae according to Thai Van Trung (1978).

### **CHAPTER 3. RESULTS AND DISCUSSION**

#### **3.1. Diversity morphological of Bambusoideae in the Central Highlands**

##### **3.1.1. Characteristics of vegetative organs**

###### **3.1.1.1. Rhizome**

Bamboo species in the Central Highlands have two main rhizome types: pachymorph rhizome and leptomorphic rhizome.

+ Pachymorph rhizome: popular with 29/31 species (93.55%), their are a characteristic feature of the genera *Annamocalamus*, *Bambusa*, *Chimonocalamus*, *Cochinchinochloa*, *Dendrocalamus*, *Gigantochloa*, *Kinabaluchloa*, *Khoonmengia*, *Maclurochloa*, *Melocalamus*, *Nianhochloa*, *Schizostachyum*, *Thyrsostachys*, *Vietnamosasa*, *Yersinochloa*.

This type of rhizome is generally with short and thick neck. At the nodes, new rhizomes or roots can be produced.

+ Leptomorph: 2 species *Vietnamosasa ciliata* và *Yushania schmidiana* (6,45%). In the monopodial or running type, the rhizome grows horizontally without frequent, upright culm repetition and hence culms always grow in isolation.

So, the rhizome is of taxonomic importance at tribe and genera.

### **3.1.1.2. Culm**

In the Central Highlands, the Bambusoideae has main culm forms: culm erect and scrambling or clambering

+ Culm erect: The culm are erect or suberect bamboos with drooping or pendulous tip. This is a common habit in the Central Highlands, found in 22/31 species (70.96%) belonging to 4 subtribes:

(1) Arundinariinae: *Chimonocalamus*, *Yushania*;

(2) Bambusinae: *Bambusa*, *Dendrocalamus*, *Giagantochloa*, *Thyrostachys*, *Vietnamosasa*;

(3) Holttumochloinae: *Kinabaluchloa*;

(4) Melocanninae: *Annamocalamus*, *Schizostachyum*.

+ Culms and branches scrambling or hanging over nearby vegetation or trees/clambering: 9/31 species (29,03%), including genera: *Cochinchinochloa*, *Khoonmengia*, *Melocalamus*, *Maclurochloa*, *Nianhochloa*, *Yersinochloa*.

### **3.1.1.3. Branch**

Branching characteristics are considered important characteristics in the subtribe.

(1) Branches a cluster of slender subequal branches, none dominant (except for the genus *Khoonmengia*) including subtribes: Arundinariinae (*Chimonocalamus*, *Yushania*); Melocanninae (*Annamocalamus*, *Schizostachyum*) and Holttumochloinae (*Kinabaluchloa*, *Nianhochloa*).

(2) Branches several with middle one dominant: including subtribes Bambusinae (*Bambusa*, *Dendrocalams*, *Cochinchinochloa*, *Gigantochloa*, *Maclurochloa*, *Melocalamus*, *Thyrsostachys*, *Vietnamosasa*, *Yersinochloa*).

#### **3.1.1.4. Culm sheath**

In the bamboo the principal appendages of the culm leaf proper are the sheath, sheath blade, auricle and ligule:

+ Sheath: sheath is often referred to lose as a leaf and cover the new culm shoots.

+ Sheath blade: there are changes in size and morphological characteristics in different species.

+ Auricles: a small band, located at the two shoulders of the tip of the sheath.

+ Ligules: between the sheath and the leaf blade.

#### **3.1.1.5. Leaf**

Leaf include the main parts:

+ Leaf sheath: above has petiole connected to leaf blade.

+ Leaf blades: The leaf blade is green, usually lanceolate, elongated and slightly oval, the tip of the leaf blade tends to taper to a sharp point.

+ Petiole: base of leaf blade to connect to leaf sheath, about 1 mm, glabrous.

+ Leaf ligule: part between leaf sheath and petiole, inner ligule a low rim.

+ Leaf auricles: at the tip of the leaf sheath, triangular, raised blade.

### **3.1.2. Reproductive**

#### **3.1.2.1. Inflorescence**

Inflorescence: semelauctant, spikelets comprising 1 to many florets, paniculate, terminal to a leafy branch or at the nodes.

Pseudospikelets and spikelets: consists of a series of overlapping, distichous bracts, some of which bear flower in their axils. Usually the lowermost two bracts of the spikelet are empty, bearing neither floral axes nor buds; there are traditionally glumes. In bamboos, the number of glumes is more variable than it is in the other grass.

Floret: consisting lemma and palea. Beside the palea, the floret bears lodicules, stamens, and gynoecium (pistil)

Lemma: above the glume. Lemma are oblong, lanceolate or ovoid.

Palea: the upper and inner scale of the grass floret which encloses the grass flower, usually 2-keeled

Lodicule: a small scale-like or fleshy structure at the base of the stamens in a grass floret, usually 2 in each floret (often 3 or more in bamboos); they swell at anthesis, causing the floret to gape open.

Stamen: above lodicule, next in other above the lodicules come the stamens. The numbers of stamens are six, each stamen consists of two parts: anther and filament.

Gynoecium: The gynoecium (pistil) consists of ovary, style and stigmas.

### **3.2.2.2. Fruit**

The Bambusoideae in the Central Highlands has two types of fruit: caryopsis (common) and flesh fruit(*Annonamcalamus*, *Melocalamus*).

## **3.1.3. Morphological characteristics of the Bambusoideae in the Central Highlands**

The result has recorded 31 species of bamboo belonging to 2 tribes, 4 subtribes and 15 genera

### **3.1.3.1. Tribe Arundinarieae**

Tribe Arundinarieae: Leptomorph, branches forming a cluster of slender subequal branches, non-dominant with branch-thorn at the node, caryopsis.

Tribe Arundinarieae has 01 subtribe is Arundinariinae.

Subtribe Arundinariinae has 3 genera:

***Chimonocalamus***: Branch complement 3 at mid-culm nodes, 3–5 at upper culm nodes, nodes with a ring thorns. Inflorescences semelauctant, paniculate, terminal to a leafy branch. Spikelets robust, 4–12 flowered with 1 vestigial terminal floret consisting of palea;

***Khoonmengia***: This genus is differs to *Chimonocalamus* in culms unicaespitose, erect at lower part, distally scrambling; branches with one central dominant branch elongating to reiterate the culm and 1–4 lateral slender ones in the middle part of culm

***Yushania***: This remarkable genus is similar to *Chimonocalamus* in the habits but different *Chimonocalamus* à *Khoonmengia* is branches often many subequal at lower nodes.

### 3.1.3.2. Tribe Bambuseae

Rhizomes pachymorph. Culms erect, scrambling, or climbing; internodes usually hollow, or a thick swollen patella at the culm nodes; nodes glabrous or covering of appressed, branches several to many, one dominant or subequal branches, none dominant

Tribe Bambuseae has 3 subtribes Bambusinae, Melocanninae and Holttumochloinae.

#### Subtribe Bambusinae

Branches several with middle one dominant, inflorescences terminating leafy branches or at node

Subtribe Bambusinae has 9 genera:

***Bambusa*:** Rhizomes sympodial; tree, shrub or scrambler; branch complement several, 1 dominant, sometimes with recurved branch-thorn at the node; inflorescence iterant, comprising an untidy tuft, pseudospikelets sessile, spikelets 1- many flowered, 1-3 terminal vestigial flowers.

***Dendrocalamus*:** This genus is similar to *Bambusa* in general appearance, but differs in having branches several to many, none to 3 dominant, without branch-thorn at the node; spikelets 1-many flowered falling together, typically without terminal vestigial flower; stigma 1.

***Gigantochloa*:** This genus differs from other genera in the subtribus Bambusinae in having auricles absent or small; lodicules absent, and other apices typically pointed filaments united into a firm tube.

***Thyrsostachys*:** This genus is similar to *Bambusa* in general appearance, but differs in having leaves small, palea prominently bifid, cleft to 1/3 of its length.

***Maclurochloa*:** differs from *Bambusa* in having only one or two perfect flowers in the spikelet, differs from *Gigantochloa* in having flowers with free filaments and emarginate anther apices. The non-fleshy fruit of *Maclurochloa* immediately distinguishes it from *Melocalamus*, which are also climbing bamboos.

***Cochinchinochloa*:** This remarkable genus is similar to *Maclurochloa* in general appearance, but is distinct in its a thick swollen patella at the culm nodes and nodes of leafy branches, pseudospikelets having two perfect florets, the rachilla internode between the perfect florets elongated.

***Melocalamus genera:*** The fleshy fruit of *Melocalamus* immediately distinguishes it from *Cochinchinochloa*, *Maclurochloa*, which are also climbing bamboos.

***Vietnamosasa:*** This genus differs from other genera in the subtribus Bambusinae in its special “grass-mound”

***Yersinochloa:*** This remarkable genus is similar to *Maclurochloa*, *Cochinchinochloa* in general appearance, but is distinct in its pseudospikelets having one perfect florets, palea unkeeled, six stamens, free filaments.

### **Subtribe Melocanninae**

Pachymorph, style long.

Subtribe Melocanninae has 2 genera:

***Schizostachyum:*** when young densely covered with appressed white hairs, becoming rough when old due to silica; branches a cluster of slender subequal branches, none dominant; blade erect or reflexed; lodicule 3, stamens 6, filament free; cariopsis.

***Annamocalamus:*** This remarkable genus is similar to *Schizostachyum* in general appearance, but is distinct in its blade erect, fleshy fruit

### **Subtribe Holttumochloinae**

The branch complement of many subequal branches, non dominant, without a thick swollen patella at the culm nodes

Subtribe Holttumochloinae has 2 genera:

***Kinabaluchloa:*** differs from *Bambusa* in having a reduced number of flowers; it is distinguished from *Gigantochloa* by the reduced number of flowers and by having rachilla internodes that disarticulate below the lemma. It differs from *Thyrsostachys* has the lowermost palea bifid, differs from *Melocalamus* is cariopsis



*Nianhochloa*: This remarkable genus is similar to *Kinabaluchloa* in general appearance, but is distinct in its clambering culm habit, glumes shorter than the lowest lemma, and short rachilla internodes between flowers.

### 3.2. Taxonomic of Bambusoideae in the Central Highlands

#### 3.2.1. Composition of classification Bambusoideae in the Central Highlands

Bambusoideae in the Central Highlands including 31 species belonging to 2 tribes, 4 subtribes and 16 genera

#### 3.2.2. Key and describe Bambusoideae in the Central Highlands

Bambusoideae Luerss., Grundz. Bot., ed. 5: 451. 1893.

Type: *Bambusa* Schreb

Bambusoideae was divided 2 tribes Arundinarieae and Bambuseae

#### KEY TO TRIBES OF BAMBUSOIDEAE

- 1a. Leptomorph, culm small, branches numerous at each mid-culm node, slender, subequal ..... Arundinarieae  
 1b. Pachymorphous, culm large, branches several with middle one dominant .....Bambuseae

#### 3.2.2.1. Tribe Arundinarieae Asch. & Graebn, 1902.

Type: *Arundinaria* Michx.

Tribe Arundinarieae has 01 subtribe is Arundinariinae.

#### Subtribe Arundinariinae Nees ex Lindl., 1836

Subtribe Arundinarieae has 3 genera.

#### KEY TO GENERA OF SUBTRIBE ARUNDINARIINAE

- 1a. Culms erect at the lower part, distally scrambling..... *Khoonmengia*  
 1b. Culms erect ..... 2  
 2a. Nodes with a ring of thorns ..... *Chimonocalamus*  
 2b. Nodes without a ring of thorns..... *Yushania*

***Khoonmengia* N.H. Xia, Y.H. Tong & X.R. Zheng, 2020**

Type species: *Khoonmengia honbaensis* N.H. Xia, Y.H. Tong & X. R. Zheng.

*Khoonmengia* genera has 01 species *K. honbaensis* N.H. Xia, Y.H. Tong & X.R. Zheng

***Chimonocalamus* Hsueh & T.P. Yi, 1979**

Type species: *Chimonocalamus delicatus* Hsueh & T.P. Yi

*Chimonocalamus* genera has 1 species *C. bidoupsensis* H.N. Nguyen & V.T. Tran was discovered as a new species.

***Yushania* P.C. Keng, 1957**

Type species: *Yushania niitakayamensis* (Hayata) Keng

*Yushania* genera has 01 species *Y. schmidiana* (A. Camus) Ohornb

**3.2.2.2. Tribe Bambuseae Kunth ex Dumort., 1829**

Tribe Bambuseae has 3 subtribes.

**KEY TO SUBTRIBES OF TRIBE BAMBUSEAE**

- 1a. Branches several with middle one dominant, filament short Bambusinae
- 1b. Branches numerous and subequal, non-dominant, filament long 2
  - 2a. Culm erect .....Melocanninae
  - 2b. Culm clambering..... Holttumochloinae

**Subtribe Bambusinae J.S. Presl, 1830**

Subtrie Bambusinae has 9 genera.

**KEY TO GENERA OF SUBTRIBE BAMBUSINAE**

- 1a. Culm erect..... 2
- 1b. Culms clambering, scrambling or hanging over nearby vegetation or trees  
..... 6
  - 2a. Culm sheaths persistent,..... 3
  - 2b. Culm sheaths early deciduous..... 4

- 3a. Culm small size..... *Vietnamosasa*  
 3b. Culm large size ..... *Thyrostachys*  
 4a. filaments joined in a tube ..... *Gigantochloa*  
 4b. Filament free ..... 5  
 5a. 1-3 terminal vestigial flowers ..... *Bambusa*  
 5b. typically without terminal vestigial flower; ..... *Dendrocalamus*  
 6a. Nodes without a thick swollen patella, auricles absent or  
 inconspicuous ..... 7  
 6b. Nodes with a thick swollen patella, auricles present ..... 8  
 7a. Fleshy fruit ..... *Melocalamus*  
 7b. Caryopsis friut..... *Cochinchinochloa*  
 8a. palea with bifid at apex ..... *Yersinochloa*  
 8b. palea apex acuminate..... *Maclurochloa*

***Bambusa* Schreb., 1789**

Types species: *Bambos arundinacea* Retz.

*Bambusa* genera has 03 species.

**KEY TO SPECIES OF BAMBUSA GENERA**

- 1a. Node with a ring hairs..... *B. gurgandii*  
 1b. Node without a ring hairs ..... 2  
 2a. Culms with many thorns ..... *B. bambos*  
 2b. Culms with many thorns ..... *B. procera*

***Cochinchinochloa* H.N. Nguyen & V.T. Tran, 2013**

Type species: *Cochinchinochloa braiana* H.N. Nguyen & V.T. Tran

*Cochinchinochloa* genera has 01 species *C. braiana* H.N. Nguyen & V.T. Tran

***Dendrocalamus* Nees, 1835**

Type species: *Dendrocalamus strictus* (Roxb.) Nees

*Dendrocalamus* genera has 1 species *D. poilanei* A. Camus

***Gigantochloa* Kurz ex Munro, 1868**

Type species: *Gigantochloa atter* (Hasskarl) Kurz ex Munro

*Gigantochloa* genera has 6 species.

**KEY TO SPECIES OF GIGANTOCHLOA GENERA**

- 1a. Mid-culm branch complement with manysubequal branches, non-dominant ..... *G. multifloscula*  
 1b. Mid-culm branch complement several with one dominant ..... 2  
 2a. Blade sheath reflexed ..... *G. poilane*  
 2b. Blade sheath erected..... 3  
 3a. The two edges of the sheath proper are not high ... *G. cochinchinensis*  
 3b. The two edges of the sheath proper are high... ..... 4  
 4a. Blade sheath short..... *G. tenuispiculata*  
 4b. Blade sheath elongated ..... 5  
 5a. Culm sheath triangular..... *G. parvifolia*  
 5b. Culm sheath elongated ..... *G. densa*

***Maclurochloa* K.M. Wong, 1993**

Types species: *Maclurochloa montana* (Ridl.) K.M. Wong

*Maclurochloa* genera has có 01 species *M. locbacensis* H.N. Nguyen & V.T. Tran

***Melocalamus* Benth., 1883**

Type species: *Melocalamus compactiflorus* (Kurz) Benth.

*Melocalamus* genera has 03 loài species.

**KEY TO SPECIES OF MELOCALAMUS GENERA**

- 1a. Auricles erect ..... *M. kbangensis*  
 1b. Auricles curved..... 2  
 2a. Culm sheaths swollen at the base ..... *M. blaoensis*

2b. Culm sheaths are not swollen at base.....*M. truongsoneensis*

***Thyrsostachys* Gamble, 1896**

Type species: *Thyrsostachys oliveri* Gamble

*Thyrsostachys* genera has 01 species *T. siamensis* Gamble

***Vietnamosasa* T.Q. Nguyen, 1990**

Type species: *Vietnamosasa darlacensis* Nguyen

*Vietnamosasa* genera has 3 species.

**KEY TO SPECIES OF VIETNAMOSASA GENERA**

1b. Rhizomes leptomorph, Culms under 1 m ..... *V. pusilla*

1a. Rhizomes pachymorph, Culms more than 2 m ..... 2

2a. Culm sheath with dense appressed hairs on the abaxial surface *V. darlacensis*

2b. Culm sheath without dense appressed hairs on the abaxial surface

..... *V. ciliata*

***Yersinochloa* H. N. Nguyen & V. T. Tran, 2016**

Type species: *Yersinochloa dalatensis* H. N. Nguyen & V. T. Tran

*Yersinochloa* genera has 2 species, of which *Y. nghiana* T.V Tran & V.T. Tran was discovered by us and announced as a new species.

**KEY TO SPECIES OF YERSINOCHLOA GENERA**

1a. Nodes with a thick swollen patella, blades sheath erect ..... *Y. nghiana*

1b. Nodes without a thick swollen patella, blades sheath reflexed..... *Y. dalatensis*

**Subtribe Holttumochloinae K.M. Wong & W. L. Goh, 2016**

In the Central Highlands, subtribe Holttumochloinae has 2 genera.

**KEY TO GENERA OF SUBTRIBE HOLTUMOCHLOINAE**

1a. Culm erect, node with a ring hairs ..... *Kinabaluchloa*

1b. Culms clambering, node without a ring hairs ..... *Nianhochloa*

***Kinabaluchloa* K.M. Wong, 1993**

Types species: *Kinabaluchloa wrayi* (Stapf) K.M. Wong

*Kinabaluchloa* genera has 1 species *K. wrayi* (Stapf) K.M. Wong

***Nianhochloa* H.N. Nguyen & V.T. Tran, 2012**

Types species: *Nianhochloa bidoupensis* H.N. Nguyen & V.T. Tran

*Nianhochloa* genera has 01 species *N. bidoupensis* H.N. Nguyen & V.T. Tran

**Subtribe Melocanninae Benth., 188**

Subtribe Melocanninae has 2 genera.

**KEY TO GENERA OF SUBTRIBE MELOCANNINAE**

1a. Culm sheaths persistent, auricles conspicuous .....*Annamocalamus*

1b. Culm sheaths early deciduous, auricles absent or inconspicuous

.....*Schizostachyum*

***Annamocalamus* H.N. Nguyen, N.H. Xia & V.T. Tran, 2013**

Type species: *Annamocalamus kontumensis* H.N. Nguyen, N.H. Xia & V.T. Tran

*Annamocalamus* gennera has 01 species *A. kontumensis* H.N. Nguyen, N.H. Xia & V.T. Tran

***Schizostachyum* Nees, 1829**

Type species: *Schizostachyum blumei* Nees.

*Schizostachyum* genera has 4 species.

**KEY TO SPECIES OF SCHIZOSTACHYUM GENERA**

1a. The apical part of the culm leaf sheath proper horizontal or only slightly concave ..... 2

1b. The apical part of the culm leaf sheath proper distinctly concave..... 3

2a. Floret 1 ..... *S. langbianense*

2b. Floret 2..... *S. locbacense*

3a. Blades sheath with base broadly rounded..... *S. yalyense*

3b. Blades sheath without base broadly rounded ..... *S. ninhthuanense*

### **3.3. Research on the distribution diversity of the Bambusoidear in the Central Highlands**

#### **3.3.1. Distribution by geographical region**

In the Central Highlands, the Bambusoideae is distributed in most geographical regions. Among the 31 species distributed in the Central Highlands, there are 9 species with distribution throughout Indochina or some countries in Asia, 3 species with distribution in all 5 provinces of the Central Highlands, and 22 species distributed in the Central Highlands that have not been recorded in other countries; these can be considered endemic species of Vietnam.

#### **3.3.2. Distribution by altitude**

In the Central Highlands, the Bambusoideae is widely distributed, in an altitudinal range that extends below 1,000 m to altitudes above 1,800 m.

(1) At altitudes below 1,000 m there are 21 species: *Annamocalamus kontumensis*, *Bambusa bambos*, *B. gurgandii*, *B. procera*, *Dendrocalamus poilanei*, *Gigantochloa cochinchinensis*, *G. densa*, *G. multifloscula*, *G. parvifolia*, *G. poilanei*, *G. tenuispiculata*, *Maclurochloa locbacensis*, *Melocalamus blaoensis*, *M. kbangensis*, *M. truongsongensis*, *Schizostachyum yalyense*, *S. ninhthuanense*, *Thyrsostachys siamensis*, *Vietnamosasa ciliata*, *V. darlacensis*, *V. pusilla*.

(2) At altitudes of 1,000 - 1,800 m, there are 16 species: *Annamocalamus kontumensis*, *Chimonocalamus bidoupensis*, *Cochinchinochloa braiana*, *Dendrocalamus poilanei*, *Gigantochloa densa*, *Khoonmengia honbaensis*, *Kinabaluchloa wrayi*, *Melocalamus kbangensis*, *M. truongsongensis*, *Nianhochloa bidoupensis*, *Schizostachyum*

*langbianense*, *S. locbacense*, *S. ninhthuanense*, *Thyrsostachys siamensis*, *Yersinochloa dalatensis*, *Y. nghiana*.

(3) At altitudes of 1,800 - 2,600 m, there are 2 species: *Yushania schmidiana*, *Schizostachyum langbianense*.

The results showed that the distribution of Bambusoideae is wide, from altitudes below 1,000 m to above 1,800 m. Among them, at altitudes below 1,000 m, there is the highest number of species (21 species), followed by altitudes from 1,000 - 1,800 m (16 species); and altitudes above 1,800 m have the least number of species, 2 species.

Among the studied species, besides species that are only distributed in certain altitude belts, there are up to 8 species distributed in many different altitude belts.

### **3.3.3. Distribution according to vegetation**

(1) Closed evergreen tropical rain forests: 16 species (51,62%).

(2) Closed evergreen tropical rain forest on lowland: 11 species (35,48%).

(3) Dry dipterocarp forest: 3 species (9,68%)

(4) Highland cold forest: 1 species (3,22%).

## **CONCLUSION AND RECOMMENDATION**

### **Conclusion**

The research results of the project have contributed some new points about the diversity of the Bamboo subfamily in the Central Highlands as follows:

1. The Bambusoideae in the Central Highlands includes 31 species belonging to 2 tribes, 4 subtribes and 16 genera. After analyzing the morphological characteristics, vegetative and reproductive organ structures of all species, a classification key for tribe, subtribe, genera and species was



built. The thesis also discovered two new scientific species: *Chimonocalamus bidoupensis* N.H. Nghia & V.T. Tran và *Yersinochloa nghiana* V.T. Tran & T.V Tran.

2. Provides morphological data (vegetative organs and reproductive in plants) of the Bambusoideae in the Central Highlands, including data on morphological characteristics of subfamily, tribe, subtribe, genus, and species. Building a key to tribes, subtribes, genera, and species of the Bambusoideae in the Central Highlands.

3. Provides data on the distribution (geographical region, altitude and vegetation type) of Bambusoideae in the Central Highlands.

### **Recommendation**

It is necessary to continue researching and supplementing missing documents and specimens, especially flowers; expanding investigation areas in different regions of the country; combining molecular biology methods to resolve some doubtful specimens; and having enough scientific basis to complete research on the bamboo subfamily in Vietnam.

Research measures to plant, preserve, and develop economically valuable bamboo species and scientifically valuable species to serve socio-economic development in the Central Highlands.

LIST OF THE PUBLICATIONS RELATED TO THE  
DISSERTATION

1. Tran Thai Vinh, Hoang Nghia Nguyen, Nong Van Duy and Van Tien Tran, 2021, *Chimonocalamus bidouppensis*, a new temperate bamboo species (Poaceae: Bambusoideae) from Bidoup National Park, southern Vietnam, *Nordic Journal of Botany*, Volume 39, Issue 1, pp 1-5. <https://doi.org/10.1111/njb.02853>
2. Tran Thai Vinh, Nong Van Duy, Hoang Thanh Truong, Tran Van Tien, 2023, *Yersinochloa nghiana*, a new species (Poaceae, Bambusoideae, Bambuseae) from southern Vietnam, *PhytoKeys*, 224, pp. 175–182. doi: 10.3897/phytokeys.24.101
3. Nong Van Duy, Tran Thai Vinh, Vu Kim Cong, Dang Thi Tham, Hoang Thanh Truong, Tran Van Tien, 2023, An updated enumeration of Bambusoideae in Central Highlands, Vietnam, *Academia Journal of Biology*, 45(4), pp 111–126. <https://doi.org/10.15625/2615-9023/18913>