

**MINISTRY OF EDUCATION SCIENCE  
AND TRAINING**

**VIETNAM ACADEMY OF  
AND TECHNOLOGY**

**GRADUATE UNIVERSITY OF SCIENCE AND TECHNOLOGY**

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**STUDY ON THE TAXONOMY AND MEDICINAL VALUE OF THE  
STERCULIACEAE IN VIETNAM**

**SUMMARY OF DISSERTATION IN BOTANY**

Code: 9.42.01.11

**Ha Noi – 2024**

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

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The dissertation will be examined by Examination Board of Graduate University of Science and Technology, Vietnam Academy of Science and Technology at 9 am; date May 16, 2024

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## PREFACE

### 1. Reason for choosing the subject

The Sterculiaceae family has 68 genera, about 1100 species distributed throughout tropical and temperate regions (Tang Y. et al., 2008). According to the Vietnam Plant List, the Sterculiaceae family has 22 genera and more than 80 species. The Sterculiaceae is known for having many species with economic value, especially medicinal value. Some species is recognized for its value as timber for making furniture or construction. In addition, many species have been recorded taking fibers from their bark to make lanyards, edible seeds, oil for lighting, etc. However, the viewpoints on the arrangement of taxa and taxonomic levels within the family are still inconsistent among different authors.

In Vietnam, there are only a few research works on Sterculiaceae as Gagnepain (1911), Pham Hoang Ho (1991, 1999), Vo Van Chi (1997, 2003, 2004, 2012), Nguyen Tien Ban (1997, 2003),... However, these works often only briefly introduce the species or only introduce the genus or the information is too old compared to current changes, causing many difficulties for studying. Besides, the current classification of the Sterculiaceae has many different viewpoints, leading to the boundaries of taxonomic levels and taxa still being inconsistent. On the other hand, most species of the Sterculiaceae family are unisexual flowers, and identification is very difficult due to the complex structure and similarities in structural characteristics of flowers between species. Therefore, to provide data on the complete morphology of taxa in the Sterculiaceae in Vietnam to identify and evaluate the medicinal value of the species, we conducted the project: *Study on the taxonomy and medicinal value of the Sterculiaceae in Vietnam*.

**2. Purpose:** Building comprehensive data on Sterculiaceae Vent. species in Vietnam, as a basis for implementing applied research related to the value of plant resources of the Sterculiaceae Vent.

### 3. Research content

Research on the taxonomic position of taxa in the Sterculiaceae Vent. family in Vietnam; select an appropriate classification system for arranging taxa of the Sterculiaceae family in Vietnam.

Research on morphological characteristics of taxa of the Sterculiaceae Vent. family in Vietnam based on results of specimen samples's analysis;

Building a dichotomous identification key to identify genera and species of the Sterculiaceae family in Vietnam.

Brief description of morphological characteristics to identify representatives of the Sterculiaceae family in Vietnam.

Develop a list of medicinal species and provide some scientific data on the antioxidant and cytotoxic activities of one species of the Sterculiaceae family.

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

- **Scientific significance:** Providing data for the classification of the Sterculiaceae family in Vietnam. Add more data about medicinal plant resources in Vietnam.

- **Practical significance:** The results of the thesis serve applied sciences in medicinal production, forestry, ecology and biological resource managements.

## **CHAPTER 1. OVERVIEW OF THE RESEARCH SUBJECT**

### **1.1. THE CLASSIFICATION SITUATION OF THE STERCULIACEAE IN THE WORLD**

Up to now, in the world, the Sterculiaceae Vent. family is recorded to have about 68 genera and 1,100 species, distributed mainly in tropical regions of the two hemispheres (Tang Y., G. G. Michael & J. D. Laurence. 2008). The first person to name the Sterculiaceae family was E.P. Ventenat ex Salisbury in 1807 with the Typus genus *Sterculia* L. This is considered a conserved family name (*nom.cons.*). The works around the world often refer to this family by the name "Cacao family" because in this family there is a famous Cocoa species that produces cocoa. In the world, there are a number of works referring to the study of classification of the Sterculiaceae Vent. family such as: De Candolle (1824), Blume (1825), G. Bentham & J. D. Hooker (1862), Maxwell T. Masters (1875), Ridley. H.N. (1922), Chatterway, M. M. (1937), A. Engler (1964), C.A. Backer & R.C. Bakhuizen (1965), J. Hutchinson (1969), Armen Takhtajan (1987, 1997). Notably, the works of Armen Takhtajan (1987, 1997) show that Sterculiaceae family belongs to the order Malvales along with other families such as Malvaceae, Tiliaceae, Bombacaceae, Elaeocarpaceae.

In Sterculiaceae family, taxa are classified into two subfamilies, which in turn include tribes and genera. The different subfamilies between the basic characteristics are fruit as capsular (including syncarpous) or follicular (including dialycarpellum or apocarpous). The Sterculiaceae family classification system is as follows: Subfam. 1: *Sterculioideae* includes 4 tribes: *Sterculieae* (9 genera), *Tarrietieae* (1

genus), *Mansonieae* (2 genera), *Triplochitoneae* (1 genus); Subfam. 2: *Byttnerioideae* includes 9 tribes: *Lasiopetaleae* (10 genera), *Hermannieae* (4 genera), *Helmiopsidae* (3 genera), *Byttnerieae* (4 genera), *Theobromeae* (7 genera), *Fermentodendreae* (2 genera), *Eriolaeneae* (1 genus), *Dombeyeae* (11 genera), *Helictereteae* (6 genera). In 2009, Armen Takhtajan, based on the characteristics as many stamens and spiny pollen grain, raised the tribe *Dombeyeae* into a separate subfamily (*Dombeyoideae*), so the total number of subfamilies of the Sterculiaceae family to 3 subfamilies: *Byttnerioideae*, *Dombeyoideae*, *Sterculioideae*.

Many perspectives based on morphological characteristics have been developed at the national level as Tang Y., G. G. Michael & J. D. Laurence. (2008) when researching plants in China, recorded that the Sterculiaceae Vent. has 19 genera and 90 species in Chinese territory.

## **1.2. ABOUT THE MEDICINAL VALUE OF THE STERCULIACEAE FAMILY IN THE WORLD**

Exactly plant classification is the basis for developing research on species with medicinal value, so information about medicinal value is often mentioned in taxonomic works. The medicinal value of species of the Sterculiaceae family has not been studied systematically, but the value of each individual species or group of species has been noticed for a long time, including some notable works such as: J. Hutchinson (1975) mentioned the value of the Cocoa species in the Sterculiaceae family. C. Phengkklai (2001) of the Sterculiaceae family found in Thailand gives information on the medicinal uses of some notable species such as *Abroma angusta*, *Scaphium linearicarpum*, *S. scaphigerum*. Tang Y. and colleagues (2008) recorded that the Sterculiaceae Vent. family in China has a number of medicinal plants including the following species: *Sterculia foetida* with medicinal seeds; *Helicteres isora* root as medicine; *S. angustifolia* roots and leaves as medicine; *Pterospermum heterophyllum* as medicine.

Recently, the biological activities of the Sterculiaceae family have been researched because of their potential for healing. The following works can be mentioned as Peter W.A. (2006), XuanSheng Hu et al., (2016), Quanfang Huang et al. (2013), Ysrael M et al., (1993).

## **1.3. THE CLASSIFICATION SITUATION OF THE STERCULIACEAE IN VIETNAM**

In 1888, F. Pierre classified 23 species in the Malvaceae, which were described in detail with their morphological characteristics, but

were later transferred to the Sterculiaceae family, distributed in southern Vietnam. Some notable later works include: F. Gagnepain in H. Lecomte. (1910), Merrill E. D., (1935), Tardieu-Blot M. in H. Lecomte (1945), L. K. Ke et al (1974), P. H. Ho (1991), N. T. Ban (1997).

#### **1.4. ABOUT THE MEDICINAL VALUE OF THE STERCULIACEAE FAMILY IN VIETNAM**

In Vietnam, the value of plants belonging to the Sterculiaceae family has been of interest since quite early such as Le Kha Ke and colleagues (1972), Pham Hoang Ho (1991), Do Huy Bich and colleagues (1990, 1993, 2004), Vo Van Chi (2012), Nguyen Tien Ban (2003), The Institute of Medicinal Materials (2016). Recently, the biological activity of some species in the Sterculiaceae family has also been developed in the direction of applied research such as Nguyen Huu Duyen and Le Thanh Phuoc, 2016; Le Trung Hieu et al., 2019; Ysrael M et al., 1993; Kim et al., 2018; Kadir 2021.

### **CHAPTER 2. RESEARCH SUBJECTS AND METHODOLOGY**

#### **2.1. RESEARCH SUBJECTS**

*Documents:* Documents on the classification of the Sterculiaceae family in the world and in Vietnam, especially monographs.

*Specimens:* Plant specimens of the Sterculiaceae family in Vietnam, currently kept in plant herbariums and specimens obtained through field investigations. Fresh specimens and dried specimens were observed and analyzed for morphological characteristics using an electron microscope connected to a screen.

The study of morphological characteristics was carried out at the Plant Department (IEBR); Department of Plant Science, Faculty of Biology, University of Sciences, Hanoi National University and a number of other plant herbariums in the country. The total number of specimens studied is 409 specimen numbers, with 1022 specimens. Research on the chemical characteristics and testing of biological activity of the species *Commersonia bartramia* is carried out at the Department of Applied Biochemistry, Institute of Chemistry, VAST, the activity test samples are stored at the Plant Department (IEBR).

#### **2.2. RESEARCH SCOPE**

Scope: Plant species of the Sterculiaceae family are distributed throughout the country. Research period: From November 2019 to November 2023.

#### **2.3. METHODOLOGY**

### ***2.3.1. Document inheritance method***

With the thesis topic on plant taxonomy, we focus on collecting documents and inheriting previous research results related to systematics and plant taxonomy about the Sterculiaceae family and Sterculiaceae in the world. In addition, documents on geography, topography, and maps are also consulted to establish field trips.

### ***2.3.2. Method for collecting fresh specimens of animals of the Sterculiaceae family:***

Fresh specimens were collected during investigative trips in several provinces and cities in the country; morphological characteristics of fresh samples can be analyzed right during the trip or preserved in alcohol as 1 alcohol: 1 water, then analyzing the samples in the laboratory. Sample collection was conducted according to the method of Nguyen Nghia Thin (2007).

### ***2.3.3. Comparative morphological method***

To study the classification of genera belonging to the Sterculiaceae family, we use comparative morphological methods. The process of observing characteristics is statistically classified into groups of selected characteristics used for comparison: whether present or not, based on which to build pairs of opposing characteristics used in dichotomous keys to recognize the samples collected.

### ***2.3.4. Sample extraction and sample separation method***

Samples obtained after preliminary processing will be extracted according to the process. A sample extraction procedure is introduced to collect MeOH residues and EtOAc residues.

### ***2.3.5. Method for isolating compounds from extraction residues***

Analysis the extracted residues by thin layer chromatography. Use column chromatography to fractionate the extracted residue and isolate substances. Extraction method according to N. K. Phi Phung, 2007.

### ***2.3.6. Method for determining the chemical structure of a compound***

The isolated compound was structurally determined by combining spectral data.

***2.3.7. Biological activity testing method:*** According to Dominic A Sudiero (1988)

Test method for DPPH antioxidant activity: The compounds and MeOH extraction residue were dissolved in DMSO at concentrations ranging from 0.5 to 128  $\mu\text{g/mL}$ . The experiment was repeated three

times with resveratrol as the control.  $EC_{50}$  is calculated based on the SC value correlated with different concentrations of the test substance.

Test method for cytotoxic activity: The cell lines used are: liver cancer Hep-G2 (Hepatocellular carcinoma), breast cancer MCF-7 (Human breast carcinoma), lung cancer A549 (Human lung carcinoma).

### **2.3.8. Mapping method for distribution**

**2.3.9. Data processing:** The data'll be calculated using Microsoft Excel.

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

### **3.1. CHOOSE THE APPROPRIATE CLASSIFICATION SYSTEM TO SORT STERCULIACEAE LENT. IN VIETNAM**

#### **3.1.1. Choose the appropriate classification system to sort sterculiaceae lent. in vietnam**

There are two views on the classification system of the Sterculiaceae Vent. family as follows:

- Viewpoint 1: The Sterculiaceae family Sterculiaceae is considered a separate family-level taxon and is ranked together with the families Malvaceae sensu stricto, Bombacaceae, Elaeocarpaceae and Tiliaceae in the order Malvales. This view is based on morphological results, also considered the traditional view of taxonomists, there are 2 types of division systems as follows:

+ Type 1: The Sterculiaceae family division system has intermediate levels from family to genus which are subfamily and tribe levels.

+ Type 2: The Sterculiaceae family division system has intermediate levels from family to genus through tribes and subtribes.

Viewpoint 2: consider the Sterculiaceae family as a subfamily taxon including Sterculioideae, Byttnerioideae, Helicteroideae, Dombeyoideae, and placed with other subfamilies such as Malvoideae, Bombacoideae, Tilioideae,... in the Cotton family Malvaceae sensu lato, Order Malvales. This viewpoint is based on the results of morphology and molecular structure characteristics. Different from the traditional view, the Sterculiaceae family is divided into subfamilies Sterculioideae, Byttnerioideae, Helicteroideae, Dombeyoideae. However, according to this point of view, there are still many positions of taxa that are not precisely known and are placed in the "uncertain group". The position of the subfamilies of the Sterculiaceae family is proven to be interspersed and closely related to the subfamilies of the Tiliaceae family. Besides, the relationship of taxa belonging to the family Sterculiaceae Sterculiaceae and family Tiliaceae does not show separation.



Therefore, within the scope of this study, we rely on the traditional view that the Sterculiaceae family is a separate family-level taxon, separated from the Malvaceae to arrange taxa in the Sterculiaceae family. Accordingly, the Sterculiaceae family is classified in the Malvales order in the Magnolia class (Magnoliopsida) along with other families as Elaeocarpaceae, Malvaceae, Tiliaceae, and Bombacaceae).

Applying a classification system that includes the subfamily level but not the tribe level is simple and easy to use for regions with a relatively small number of genus-level taxa like Vietnam. Therefore, in the research content of the thesis, we choose the viewpoint of Y. Tang, G. G. Michael & J. D. Laurence., (2008) to arrange taxa of the Sterculiaceae family in Vietnam.

Accordingly, the Sterculiaceae Vent. family in Vietnam has 4 subfamilies and 23 genera.

**Subfam.** 1. Sterculioideae (9 genera): *Cola*, *Firmiana*, *Heritiera*, *Pterocymbium*, *Scaphium*, *Sterculia*, *Pterygota*, *Tarritiera*, *Hildegardia*.

**Subfam.** 2. Helicteroideae (2 genera): *Helicteres*, *Reevesia*.

**Subfam.** 3. Byttnerioideae (9 genera): *Abroma*, *Byttneria*, *Commersonia*, *Guazuma*, *Kleinhovia*, *Leptonychus*, *Melochia*, *Theobroma*, *Waltheria*.

**Subfam.** 4. Dombeyoideae (3 genera): *Eriolaena*, *Pterospermum*, *Pentapetes*.

### 3.1.2. Taxonomic position of the Sterculiaceae family

Plant Kingdom: Plantae; Magnolia phylum: Magnoliophyta; Class Magnolia: Magnoliopsida; Order: Malvales.

## 3.2. MORPHOLOGICAL CHARACTERISTICS OF STERCULIACEAE FAMILY IN VIETNAM

Sterculiaceae Vent. 1807. Parad. Lond. 69. nom.cons.

Life form: Wood (*Sterculia*, *Heritiera*, *Reevesia*,...), or bush (*Helicteres*), rarely wood climber (*Byttneria*) or herb (*Waltheria*, *Pentapetes*); The stem bark is often mucous and fibrous; The trunk and young branches are often covered with star-shaped hairs.

Stipules: Always have stipules, needle-shaped, awl-shaped, triangular, narrow, thread-shaped, stipules can be whole or split at the top, and often fall off soon.

Leaves: Mostly simple, rarely compound (*Sterculia foetida*, *Heritiera*), alternate. Many species of leaves on young trees have a different morphology than on adult trees (*Pterospermum*). Leaves come in many shapes and sizes; The most common leaves are whole or lobed

in the shape of a propeller; Leaf veins have two types of pinnate veins (*Helicteres*, *Reevesia*) or propeller veins (*Abroma*, *Pterospermum*, *Sterculia*); Leaf stalks are often bulging at both ends, so they are often called "glass-shaped stalks". All species have two green sides, only the *Pterospermum* genus has dark green leaves on the upper side and a pinkish white underside due to the color of star-shaped hairs.

Inflorescence: Flowers axillary or panicle, racemose (*Sterculia*), in leaf axils (*Helicteres*) or terminal (*Melochia*); The inflorescence axis is long and slender (*Sterculia*), or hard (*Reevesia*), peduncle hairy.

Flowers: Usually bisexual (*Byttnerioideae*, *Helicterioideae*, *Dombeyoideae*) or unisexual (*Sterculioideae*), there are both unisexual and bisexual flowers on the same tree (*Sterculia*). Inflorescence sample 5. Flowers evenly.

Sepals: 5 separate sepals (*Sterculia*, *Leptonychus*), acute or acuminate apex, apex of sepals stick together to form a lantern-like shape, when the flower blooms, the sepals separate; sepals partially merge at the bottom to form a bell, cup, or dome shape (*Sterculia*), 3 sepals join together in the lower half (*Reevesia*), 4-5 lobes (*Reevesia*, *Sterculia*, *Helicteres*, *Byttneria*); The lobes may be equal or irregular.

Petals: 5 separate petals, ovoid or oblong,...; petals even or irregular; two wings are larger than the other three; The remaining three wings are also gradually smaller (*Helicteres*). Petals are white (*Reevesia*), pink (*Reevesia*, *Waltheria*, *Melochia*) or red (*Pentapetes*); have two ears on the sides (*R. yersinii*, *Helicteres*), ears on the top (*Helicteres*) or none. Rarely, completely reduced to form petalless flowers (*Sterculia*).

Gynostemium: The flower base is elongated to form the pistil axis; long or short depending on the genus, from about 0.5-3.5 cm; hairy or not, with stamens and pistils on top.

Stamens: many stamens, anthers 2 cells, open longitudinally. Pollen grain membranes are often rough, with or without spines.

Pistil: Upper ovary. The ovary is combined (*Pterospermum*, *Abroma*) or almost separate (in *Sterculia* there is a separate ovary but the style is attached). The styles of all bulbs join together to form a single or sometimes separate style.

Fruit: Fruit consists of many macroscopic fruits (*Heritiera*, *Heritiera*, *Scaphium*) or capsules (*Pterospermum*, *Reevesia*, *Helicteres*), when ripe, split into fruit pieces, or dry drupes (*Theobroma*), some representatives of winged fruits (*Abroma*).

Seeds: Seeds are winged (*Reevesia*) or wingless, with many different shapes and sizes; the seed surface has cavities, spines (*Kleinhovia*), wrinkled or smooth, with seed coat (*Cola*).

Typus: *Sterculia* L. Sterculiaceae 68 genera, about 1,100 species. Vietnam has 4 subfamilies, 23 genera, 87 species and subspecies.

### 3.3. USING THE DICHOTOMOUS KEY TO IDENTIFY THE SUBFAMILY AND GENERATE OF THE STERCULIACEAE FAMILY IN VIETNAM

- 1A. The carpels are separate.....I. STERCULIOIDEAE
- 2A. flower without petals
- 3A. Indehiscent follicle fruit ..... 1. *Heritiera*
- 3B. Dehiscent follicle fruit
- 4A. One seed per follicle
- 5A. Leaf with segment. Seed without wing, with aril. 2. *Scaphium*
- 5B. Leaf compound palmate. Seed with wing, without aril.....  
.....3. *Tarrietia*
- 4B. More than one seed per follicle
- 6A. Thin pericarpe, follicle dehiscent before ripe ..... 4. *Firmiana*
- 6B. Pachycarpous, follicle dehiscent when ripe
- 7A. Seed with long wing. Follicle with long peduncle. ....  
..... 5. *Pterygota*
- 7B. Seed without wing. Follicle without long peduncle.
- 8A. Follicle with wing ..... 6. *Hildegardia*
- 8B. Follicle without wing
- 9A. Seed without aril. Sepal has only one colour as white, pink, red or reddish-brown. .... 7. *Sterculia*
- 9B. Seed with aril. Sepal yellow with central brown spot....  
..... 8. *Cola*
- 2B. flower with petals ..... 9. *Pterocymbium*
- 1B. The carpels are connect together
- 10A. Gymnostemium more than petal. .... II. HELICTEROIDEAE
- 11A. 2 seed per carpel. Seed membrane wing, 20 mm long (with wing); inflorescent terminal, fillament very short or near sessile .....  
..... 10. *Reevesia*
- 11B. More than 2 seed per carpel. Seed without wing, ca. 4 mm long; inflorescent axillary, fillament long, completely separate from the anthers ..... 11. *Helicteres*
- 10B. Gymnostemium very short or sessile.
- 12A. Pollen grains without spines ..... III. BYTTNERIOIDEAE

- 13A. Flowers do not have staminodes  
 14A. Ovary with 5 ovulophore, style 5, stigma smooth **12. *Melochia***  
 14B. Ovary with 1 ovulophore, style 1, stigma with hair .....  
 ..... **13. *Waltheria***
- 13B. Flowers do have staminodes  
 15A. Fruit indehiscent when ripe; flower in old branch without leaf. .... **14. *Theobroma***  
 15B. Fruit dehiscent when ripe; flower in young branch with leaf.  
 16A. Stament 5 or 10, fillament not into bunch  
 17A. Staminodes with obtusa apex, fruit with spines.....  
 ..... **15. *Byttneria***  
 17B. Staminodes with acute apex, fruit without spines. Đinh nhĩ lép nhọn, quả không có gai  
 18A. Fruit with hair more than 1 cm long; fruit without wing..... **16. *Commersonia***  
 18B. Fruit with hair shorter than 0.5 cm long; fruit with wing. .... **17. *Leptonychia***
- 16B. Stament 15, fillament into bunches  
 19A. fruit with wing..... **18. *Abroma***  
 19B. fruit without wing  
 20A. Petal with needle-shaped appendage 2 lobes. Seed without spines ..... **19. *Guazuma***  
 20B. Petal without appendage. Seed with spines. ....  
 ..... **20. *Kleinhovia***
- 12B. Pollen grains with spines ..... **IV. DOMBEYOIDEAE**  
 21A. Petal red, herbaceous..... **21. *Pentapetes***  
 21B. Petal white, yellow, orange. Tree or shrub or rare liana.  
 22A. Stamine 15, staminoides line ..... **22. *Pterospermum***  
 22B. Stamine 40-50, staminoides with wing or without .....  
 ..... **23. *Eriolaena***

### **3.4. MORPHOLOGICAL CHARACTERISTICS AND DICHOTOMUS KEY FOR IDENTIFICATION SPECIES OF THE STERCULIACEAE FAMILY IN VIETNAM**

#### **Subfam. STERCULIOIDEAE Burnett.**

Monoecious or polygamous plants. The ovary consists of separate carpels. The fruit consists of 1-5 follicle, follicle are separate. There are 12 genera and about 400 species in the world, distributed in tropical regions worldwide. Vietnam has 7 genera.

### 3.4.1. HERITIERA Aiton – CUI TIM

Woody stem, no petals; the carpels separate. The fruit follicle indehiscent. Typus: *H. littoralis* Aiton. There are about 17 species, distributed all over the world. Vietnam has 4 species.

Dichotomous key for identification species of genus *Heritiera* Aiton

1A. The underside of the leaf blade has dense white stellately hairs.

2A. Leaves large, 10 to 15 cm long; 7 to 15 cm wide. .. 1. *H. macrophylla*

2B. Leaves small, 6 to 12 cm long; 3 to 6.5 cm wide.

3A. Petiole 2 to 9 cm long; anthers 4-5 units; line up 1 row; fruit wing 1 cm long. ....2. *H. angustata*

3B. Petiole <1 cm long; anthers 8-12 units; line up 2 row; fruit wing < 0.5 cm long .....3. *H. littoralis*

1B. The underside of the leaf blade has without hair or scatter white stellately hairs .....4. *H. cordata*

Spe. 1.1. *Heritiera macrophylla* Wall. ex Kurz.

Spe. 1.2. *Heritiera angustata* Pierre

Spe. 1.3. *Heritiera littoralis* Aiton

Spe. 1.4. *Heritiera cordata* Kosterm.

### 3.4.2. SCAPHIUM Schott. & Endl. – LUOI UOI, UOI

Tree. Leaves are simple, with lobed. There are no petals. Fruit 2-5 follicle, with wings. Typus: *Scaphium macropodum* (Miq.) Beumée ex K. Heyne. There are about 10 species in the world, distributed in tropical Asia. Vietnam has 1 species.

Spe. 2.1. *Scaphium macropodum* (Miq.) Beumée ex K. Heyne

### 3.4.3. TARRIETIA Blume – HUYNH

Timbertree. Leaf compound palmate, without petal, carpel separate. Fruit follicle, dehiscent when ripe; one seed per follicle. Typus: *Tarrietia javanica* Blume. There are 12 species distributed all over the world. Vietnam has 1 species.

Spe. 3.1. *Tarrietia javanica* Blume

### 3.4.4. FIRMIANA Marsili – BO RUNG

Middle tree. There are no petals. Fruit follicle dehiscent before ripe, 2-4 seeds each follicle. Typus: *Firmiana platanifolia* (L. f.) Schott & Endl. About 156 species, distributed in India, China, Myanmar, Thailand, Laos, Cambodia, and Malaysia. Vietnam has 2 species.

Dichotomous key for identification species of genus *Firmiana*

1A. Petiole 7-18 cm long. Sepal 2 cm long ..... 1. *F. colorata*

1B. Petiole ca. 30 cm long. Sepal 9 mm long. .... 2. *F. simplex*

Spe. 4.1. *Firmiana colorata* (Roxb) R. Br.

Spe. 4.2. *Firmiana simplex* (L.) W. Wight.

### 3.4.5. PTERYGOTA Schott & Endl. – SANG CANH

Timber tree. Without petal; carpel separate. Fruit follicle, dehiscent when ripe, 6-10 seed per follicle. Seed with wing. *Typus: Pterygota alata* (Roxb.) R. Br. There are about 17 species in the world, distributed in the tropics. Vietnam has 1 species.

Spe. 5.1. *Pterygota alata* (Roxb.) R. Br.

### 3.4.6. STERCULIA L. – Sang

Tree or shrub. There are no petals; carpel separate. Fruit follicle, dehiscent when ripe, no wings; pachycarpous; 2-many seeds per follicle. Seeds without wings. *Typus: S. foetida* L. About 100 to 150 species in the tropics or subtropics of the two hemispheres, most abundant in tropical Southeast Asia; 24 species and subspecies in Vietnam.

Dichotomous key for identification species of genus *Sterculia*

1A. Leaf compound palmate.

2A. Sepal reddish, 10-12 mm long ..... 1. *S. foetida*

2B. Sepal white, 3-5 mm long ..... 2. *S. pexa*

1B. Leaf single

3A. Leaf with lobes palmate.

4A. 2 seed per follicle ..... 3. *S. hypochroa*

4B. 6-7 seed per follicle ..... 4. *S. thorelii*

3B. Leaf entire

5A. Base vein 3-7

6A. Leaf base cordate ..... 5. *S. stigmatota*

6B. Leaf base without cordate

7A. Leaves are 2.5-2 times longer than they are wide. Sepal pink. .... 6. *S. lissophylla*

7B. Leaves are 4 times longer than they are wide. Sepal white-green ..... 7. *S. principis*

5B. Without base vein

8A. The upper surface of the leaf blade with hairy.

9A. The leaf blade is obovate (the widest width of the leaf blade is at the top half).

10A. The leaves 2.5 - 3 times longer than wide, sepals nearly separate. .... 8. *S. hymenocalyx*

10B. The leaves 1.5 - 2 times longer than wide, sepals connect up over 1/3 from base. .... 9. *S. parviflora*

9B. Elliptic-oblong leaf blade (widest width of leaf blade in the middle).

- 11A. Petiole 5-7 cm long ..... 10. *S. radicans*  
 11B. Petiole < 4 cm long.  
     21A. The leaves have white hairs on the underside .....  
     ..... 11. *S. pierrei*  
     21B. The leaves have reddish-brown hairs on the underside. .  
     ..... 12. *S. tonkinensis*
- 8B. The upper surface of the leaf blade without hairy  
 13A. Petiole < 10 mm long ..... 13. *S. konchurangensis*  
 13B. Petiole more than 15 mm long  
     14A. Leaf veins curl together  
     15A. Lateral veins more than 6 pairs.  
     16A. Lateral veins 6-10 pairs  
     17A. Petiole 3-8 cm long  
     18A. Sepal red; round apex ..... 14. *S. lanceolata*  
     18B. Sepal reddish-brown; acute apex .... 15. *S. aberrans*  
     17B. Petiole 2 cm long  
     19A. Leaves >5 times longer than wide; calyx tube as  
     long as calyx lobe. .... 16. *S. hyposticta*  
     19B. Leaves 3-4 times longer than wide; calyx near  
     separate ..... 17. *S. bracteata*  
     16B. Lateral veins 10 -15 pairs ..... 18. *S. henryi*  
     15B. Lateral veins 5-6 pairs ..... 19. *S. cochinchinensis*
- 14B. Leaf veins without curl together  
 20A. Sepal 4.5 mm long ..... 20. *S. gracilipes*  
 20B. Sepal more than 5 mm long  
     21A. Petiole 2-5 cm long  
     22A. style curved, 1-2 seeds per follicle .....  
     ..... 21. *S. nobilis*  
     22B. style straight, 3-6 seeds per follicle .....  
     ..... 22. *S. balanghas*  
     21B. Petiole 7-10 cm long ..... 23. *S. scandens*
- Spe. 6.1. *Sterculia foetida* L.  
 Spe. 6.2. *Sterculia pexa* Pierre  
 Spe. 6.3. *Sterculia hypochroa* Pierre  
 Spe. 6.4. *Sterculia thorelii* Pierre  
 Spe. 6.5. *Sterculia stigmarota* Pierre  
 Spe. 6.6. *Sterculia lissophylla* Pierre  
 Spe. 6.7. *Sterculia principis* Gagnep.  
 Spe. 6.8. *Sterculia hymenocalyx* K. Schum.

- Spe. 6.9. *Sterculia parviflora* Roxb. ex G. Don  
 Spe. 6.10. *Sterculia radicans* Gagnep. in H. Lecomte.  
 Spe. 6.11. *Sterculia pierrei* Gganep.  
 Spe. 6.12. *Sterculia tonkinensis* A. DC.  
 Spe. 6.13. *Sterculia konchurangensis* C.N.Kieu, D.B.Tran & B.H.Quang  
 Spe. 6.14. *Sterculia lanceolata* Cav.  
 6.14A. *Sterculia lanceolata* var. *lanceolata*.  
 6.14B. *Sterculia lanceolata* var. *coccinea*.  
 Spe. 6.15. *Sterculia aberrans* Tardieu  
 Spe. 6.16. *Sterculia hyposticta* Miq.  
 Loài 6.17. *Sterculia bracteata* (Pierre) Gagnep.  
 Spe. 6.18. *Sterculia henryi* Hemsl.  
 Spe. 6.19. *Sterculia cochinchinensis* Pierre  
 Spe. 6.20. *Sterculia gracilipes* Pierre  
 Spe. 6.21. *Sterculia nobilis* Smith  
 Spe. 6.22. *Sterculia balanghas* L.  
 Spe. 6.23. *Sterculia scandens* Hemsl.

#### **3.4.7. HILDEGARDIA Schott & Endl. – TROM BAI CANH**

Woody tree, without petals. Carpels separate. Fruit follicle, dehiscent when ripe, has wings, 2 seeds per follicle. Seeds without wing. Typus: *Hildegardia populifolia* (Roxb.) Schott. & Endl. There are 12 species in the world, distributed throughout the tropics (West Africa, East Africa, Madagascar, southern India, Philippines, Indonesia, northern Australia and Cuba). Vietnam has 1 species.

Spe 7.1. *Hildegardia populifolia* (DC.) Schott & Endl.

#### **3.4.8. COLA Schott & Endl. – CO LA**

Wood tree, carpels separate; follicle dehiscent when ripe, without wings, skin hard and tough; 4-10 seeds per follicle. Seeds are wingless, red seed aril. Typus: *Cola acuminata* (P. Beauv.) Schott & Endl. There are more than 20 species, distributed in African countries, America, some West Asian countries and some other tropical countries around the world. Vietnam has 1 species.

Spe. 8.1. *Cola nitida* (Vent.) Schott & Endl.

#### **3.4.9. PTEROCYBIUM R. Br. – DUC NANG**

Wood tree. There are petals. Carpels separate, follicle thin membrane-like wings. Winged seeds. Typus: *Pterocymbium javanicum* R. Br. There are about 10 species, distributed in tropical Asian countries and Pacific islands. Vietnam has 2 species.

Dichotomous key for identification species of genus *Pterocymbium*



1A. Petiole 12-20 cm long; sepal 1 – 1.5 cm long .....1. *P. dongnaiense*

1B. Petiole 3-8 cm long; sepal more than 2 cm long. ....

.....2. *P. tinctorium* var. *javanicum*

Spe. 9.1. *Pterocymbium dongnaiense* Pierre

Spe 9.2. *Pterocymbium tinctorium* var. *javanicum* (R.Br.) Kosterm.

**Subfam. HELICTEROIDEAE (Schott. & Endl.) Meisn. – Phan ho Thau ken**

Flowers bisexual; gynostemium longer than petals and twice as long as ovary; ovary connect celled; capsule dehiscent into loculed. There are 6 genera, about 70 species, distributed mainly in tropical regions of the world. Vietnam has 2 genera.

**3.4.10. REEVESIA Lindl. – THOA LA**

Tree or Shrub. Gymnostemium very long, longer than the petals. The carpels connect, each carpel 2 seeds, seeds have membranous wings. Typus: *R. thyrsoidea* Lindl. There are about 10 species, distributed in tropical Asian countries and Pacific islands. Vietnam has 6 species.

Dichotomous key for identification species of genus *Reevesia* Lindl.

1A. Petiole  $\leq$  20 mm long

2A. Petiole 20 mm long ..... 1. *R. gagnepainiana*

2B. Petiole 10-15 mm long

3A. Secondary veins 4-6 pairs, capsular 6 cm long . 2. *R. macrocarpa*

3B. Secondary veins 8 pairs, capsular 2.5-3 cm long ..3. *R. thyrsoidea*

1B. Petiole  $\geq$  30 mm long

4A. Sepal 2 cm long ..... 4. *R. orbicularis*

4B. Sepal under 1 cm long.

5A. Sepal 9 mm long, gynostemium more than 30 mm long .....

..... 5. *R. pubescens*

5B. Sepal 6 mm long, gynostemium 20 mm long .....6. *R. yersinii*

Spe. 10.1. *Reevesia gagnepainiana* Tardieu.

Spe. 10.2 *Reevesia macrocarpa* Li.

Spe. 10.3. *Reevesia thyrsoidea* Lindl.

Spe. 10.4. *Reevesia orbiculare* Tardieu

Spe. 10.5. *Reevesia pubescens* Mast.

Spe. 10.6. *Reevesia yersinii* A. Chev.

**3.4.11. HELICTERES L. – THAU KEN**

Shrub, long stamens separate from anthers. Gynostemium longer than petals. Carpels connect, many seeds per loculed. Typus: *Helicteres isora* L. LT designated by N. L. Britton & Millspaugh, Bahama Fl. 275 (1920). There are about 60 species,

distributed mainly in tropical regions of Asia and America. Vietnam has 12 species, distributed throughout the North and South.

Dichotomous key for identification species of genus *Helicteres*

1A. Leaf blades oval, ovate, 1.5-2 times longer than wide.

2A. Petal bright red or dark-red.

3A. Capsular not twist after opening, the petals are bright red. .... 1. *H. hirsuta*

3B. Capsular twist after opening, the petals are dark red. .... 2. *H. isora*

2B. Petal white, yellow, orange or pink.

4A. Petal pink. Cánh hoa màu hồng ..... 3. *H. daknongensis*

4B. Petal white, 2 units with yellow inner. .... 4. *H. viscida*

1B. Leaf blades narrow, 2.5-5 times longer than wide.

5A. The leaf length is 5 times the width. .... 5. *H. binhthuanensis*

5B. The leaf length is 1.5-4 times the width.

6A. The leaf length is 1.5-2.5 times the width ..... 6. *H. angustifolia*

6B. The leaf length is 3-4 times the width.

7A. The leaf blades grayish white on the underside 7. *H. dakmilensis*

7B. The leaf blades without grayish white on the underside

8A. Petal under 10 mm long.

9A. Petal yellow ..... 8. *H. lanceolata*

9B. Petal without yellow ..... 9. *H. lanata*

8B. Petal more than 10mm long

10A. Petals have the same shape ..... 10. *H. poilanei*

10B. Petals have not the same shape

11A. Sepal more than 10 mm long ..... 11. *H. taynguyenensis*

11B. Sepal under 8 mm long ..... 12. *H. elongata*

Spe. 11.1. *Helicteres hirsuta* Lour.

Spe. 11.2. *Helicteres isora* L.

Spe. 11.3. *Helicteres daknongensis* V.S.Dang & D.T.Bui

Spe. 11.4. *Helicteres viscida* Blume

Spe. 11.5. *Helicteres binhthuanensis* V.S.Dang

Spe. 11.6. *Helicteres angustifolia* L. – Thau ken la hep.

Spe. 11.7. *Helicteres dakmilensis* V. S. Dang, Vuong & Bao

Spe. 11.8. *Helicteres lanceolata* DC. – Thau ken thon.

Spe. 11.9. *Helicteres lanata* (Teysm. & Binn.) Kurz

Spe. 11.10. *Helicteres poilanei* Tardieu.

Spe. 11.11. *Helicteres taynguyenensis* V.S.Dang, Vuong & Naiki

Spe. 11.12. *Helicteres elongata* Wall. ex Mast.

**Subfam. BYTTNERIOIDEAE Burnett. – PHAN HO BICH NU**

Flowers bisexual; gynostemium absent or very short, not as long as petals; pollen grains do not have spines; ovary consists of connect carpels; capsule. There are 34 genera, distributed in tropical regions of the world. Vietnam has 9 genera.

#### **3.4.12. MELOCHIA L. – TRUNG CUA**

Pollen grains do not have spines; no staminodes; no gynostemium. Carpels connect, style 5; stigma smooth, capsule. *Typus: Melochia corchorifolia* L. There are about 50-60 species, distributed in tropical countries, subtropical Malaysia, Pacific islands, Central and South America. Vietnam 3 species, distributed from North to South.

Dichotomous key for identification species of genus *Melochia*

1A. The widest of the petals is near the base..... 1. *M. corchorifolia*

1B. The widest of the petals is middle

2A. Sepal connect at the half into tube, herbaceous..... 2. *M. nodiflora*

2B. Sepal connect over the half into tube, tree ..... 3. *M. umbellata*

Spe. 12.1. *Melochia corchorifolia* L.

Spe. 12.2. *Melochia nodiflora* Sw.

Spe. 12.3. *Melochia umbellata* (Houtt.) Stapf

#### **3.4.13. WALTHERIA L. – HOANG TIEN**

Herbaceous, stamens 5, pollen grains without spines; no staminodes. There is no gynostemium, carpels connect, ovary 1 locule, each locule 1 ovule; style 1, capsule. *Typus: Waltheria americana* L. There are 4 species distributed mainly in Asia and Africa. Vietnam has 1 species.

Spe. 13.1. *Waltheria indica* L.

#### **3.4.14. THEOBROMA L. – CA CAO**

Timber tree, petal have appendages at apex, 5 stamens, 5 staminodes, pollen grains do not have spines. Gynostemium is unclear, carpels connect. The fruit indehiscent when ripe. *Typus: Theobroma cacao* L. 12 species distributed all over the world. Vietnam has 1 species.

Spe. 14.1. *Theobroma cacao* L. – Ca cao.

#### **3.4.15. BYTTNERIA Loefl. – BICH NU**

Wooden climber. Petals have appendages, filament not into bundles; pollen grains do not have spines; staminodes apex obtuse, without gynostemium, carpels connect. Capsule, dehiscent when ripe, with spines. *Typus: Byttneria scabra* L. There are about 130 species in the world, distributed in the tropics. Vietnam has 6 species scattered throughout from North to South.

Dichotomous key for identification species of genus *Byttneria* Loefl.

1A. Leaf with segment

- 2A. 7 base veins ..... 1. *B. andamensis*  
 2B. 7 base veins  
     3A. Leaf glabrous, petiole 5-9 cm long ..... 2. *B. erosa*  
     3B. Leaf hairy, petiole more than 15 cm long ..... 3. *B. pilosa*  
 1B. Leaf entire  
     4A. Leaf with apex acuminate 1-4 cm long..... 4. *B. tortilis*  
     4B. Leaf without apex acuminate  
         5A. Capsular diameter ca. 2.5 cm. Leaves glabrous. .... 5. *B. aspera*  
         5B. Capsular diameter ca. 2.0 cm. Leaves hairy in veins 6. *B. echinata*  
 Spe. 15.1. *Byttneria andamensis* Kurz  
 Spe. 15.2. *Byttneria erosa* Gagnep.  
 Spe. 15.3. *Byttneria pilosa* Roxb.  
 Spe. 15.4. *Byttneria tortilis* Gagnep.  
 Spe. 15.5. *Byttneria aspera* Colebr.  
 Spe. 15.6. *Byttneria echinata* Wall. in Kurz.

### 3.4.16. COMMERSONIA J. R. Forst. & G. Forst. – CHUNG SAO

Inflorescences on leaf-bearing branches. Stamine 5; staminodes acute apex; pollen grains do not have spines. Gynostemium very short. Carpels connect. Capsular dehiscent when ripe, has no wings, with hairs longer than 1 cm. Typus: *C. echinata* J. R. Forst.

Spe. 16.1. *Commersonia bartramia* (L.) Merr.

### 3.4.17. LEPTONYCHIA Turcz. – SONG GIAM

Gynostemium short; stamens 10, staminodes acute apex, the filaments are not attached into bundles, and the pollen grains do not have spines. Capsule with wings, dehiscent when ripe, hairy up to 5 mm long outer. Typus: *Leptonychia glabra* Turcz. There are nearly 50 species in the world. Vietnam has 1.

Spe. 17.1. *Leptonychia acuminata* Mast.

### 3.4.18. ABROMA Jacq. – TAI MEO, VONG VANG

Stamine 15; fillament into bundles, pollen grains do not have spines, gynostemium very short or sessile. Carpels connect. Capsule, with membranous wings. Typus: *A. angustum* (L.) L. There are 2 species, distributed in tropical Asia to Australia. Vietnam has 1.

Spe. 18.1. *Abroma angustum* (L.) L. f.

### 3.4.19. GUAZUMA Mill. – THUC DIA

Timber tree. The flowers are on leaf-bearing branches, with needle-shaped appendages two lobes. 15 stamens, fillament into 5 bundles; pollen grains do not have spines; 5 staminodes. Gynostemium short. Carpels connect. Capsular no wings, dehiscent when ripe. Typus:

*Guazuma ulmifolia* Lam. LT designated by Hutchinson, Gen. Fl. Pl. 2: 514 (1967). There are about 26 species, distributed all over the world. Vietnam has 1.

Spe. 19.1. *Guazuma ulmifolia* Lamk.

**3.4.20. KLEINHOVIA L. – TRA (DO), TRAC, TRA**

Inflorescences on branches with leaves. Petals no appendages, 15 stamens, fillament into 5 bundles; pollen grains do not have spines, gynostemium very short, smooth. Carpels connect. Capsule has no wings, dehiscent. Seeds have spines. Typus: *Kleinhovia hospita* L. only 1 species, distributed in tropical countries of Africa, Asia, and Australia  
Spe. 20.1 *Kleinhovia hospita* L.

**Subfam. DOMBEYOIDEAE Beilschm. – PHAN HO HONG MANG**  
gynostemium very short sessile; pollen grains spines; Carpels connect. Vietnam has 4 general.

**3.4.21. PENTAPETES L. – NGU PHUONG**

Perennial herbaceous or semi-shrub. Petals 5, bright red. Gynostemium absent, pollen grains spines. Typus: *P. phoenicea* L. There is only one species, *P. phoenicea* L., widely distributed throughout tropical Asia.

Spe. 21.1. *Pentapetes phoenicea* L.

**3.4.22. PTEROSPERMUM Schreb. – LONG MANG, HONG MANG**

Timber tree. Petals white, pale yellow. Gynostemium absent or very short. 15 stamens, have staminodes white, pollen grains with spines; Carpels connect. Capsule. Typus: *Pterospermum lanceaefolium* Roxb. 30 species distributed in tropical Asia. Vietnam has 14 species.

Dichotomous key for identification species of genus *Pterospermum*

1A. Petiole 5 cm long ..... 1. *P. acerifolium*

1B. Petiole under 3 cm long.

2A. Capsule more than 6 cm long.

3A. Capsule curved ..... 2. *P. truncatolobatum*

3B. Capsule without curved

4A. Capsule more than 20 cm long ..... 3. *P. diversifolium*

4B. Capsule ca. 6-10 (15) cm long.

5A. Leaf with segment at apex.

6A. Petal ca. 5 cm long ..... 4. *P. grandiflorum*

6B. Petal under 4 cm long ..... 5. *P. grewiiifolium*

5B. Leaf without segment at apex

7A. Leaf with sagittate base. .... 6. *P. semisagittatum*

7B. Leaf without sagittate base

- 8A. Leaf with apex acuminate .....7.*P. megalocarpum*  
 8B. Leaf without apex acuminate  
   9A. Leaf blade sagittate .....8.*P. angustifolium*  
   9B. Leaf blade not sagittate  
     10A. Young branches glabrous .....9.*P. mengii*  
     10B. Young branches hairy  
       11A. Young branches brown-red stellately hairy.  
       Capsule 10 cm long.  
       .....10.*P. argenteum*  
       11B. Young branches greyish stellately hairy. Capsule  
       7-10 cm long. ....  
       .....11.*P. mucronatum*  
 2B. Capsule under 6 cm long.  
   12A. Capsule 3 edges .....12. *P. venustum*  
   12B. Capsule without 3 edges  
     13A. Capsule round apex .....13.*P. heterophyllum*  
     13B. Capsule acute apex .....14. *P. lanceifolium*  
 Spe. 22.1. *Pterospermum acerifolium* Willd.  
 Spe. 22.2. *Pterospermum truncatolobatum* Gagnep.  
 Spe. 22.3. *Pterospermum diversifolium* Blume  
 Spe. 22.4. *Pterospermum grandiflorum* Craib.  
 Spe. 22.5. *Pterospermum grewiifolium* Pierre  
 Spe. 22.6. *Pterospermum semisagittatum* Buch.-Ham. ex Roxb.  
 Spe. 22.7. *Pterospermum megalocarpum* Tardieu  
 Spe. 22.8. *Pterospermum angustifolium* Tardieu  
 Spe. 22.9. *Pterospermum mengii* P. Wilkie.  
 Spe. 22.10. *Pterospermum argenteum* Tardieu  
 Spe. 22.11. *Pterospermum mucronatum* Tardieu  
 Spe. 22.12. *Pterospermum venustum* Craib.  
 Spe. 22.13. *Pterospermum heterophyllum* Hance  
 Spe. 22.14. *Pterospermum lanceifolium* Roxb. ex DC.

### 3.4.23. ERIOLAENA DC. – BONG BAI

Timbertree. Gynostemium very short, shorter than petals; yellow petals; stamens numerous, 45-50, pollen grains with spines; no staminodes. The ovary has 5-loculed. Typus: *Eriolaena wallichii* DC. There are about 143 species, distributed all over the world. Vietnam has 1 species.

Spe. 23.1. *Eriolaena candollei* Wall.

### 3.5. MEDICINAL PLANT VALUE OF SPECIES OF THE STERCULIACEAE FAMILY IN VIETNAM

### 3.5.1. Diversity of diseases group are treated

A list of medicinal species belonging to the Sterculiaceae family has been developed, including 33 species. The medicinal species are quite diverse in terms of parts used and types of diseases treated.

**Tab. 3.4. Diversity of diseases group treated with plant medicine**

N0	Diseases group	Number of species	Ratio % per total
1	Cold, fever diseases group	9	27.3
2	Respiration diseases group	7	21.2
3	Hematology diseases group	3	9.1
4	Mental diseases group	3	9.1
5	Digestion diseases group	17	51.5
6	Excretory system, liver and kidneys diseases group	15	45.5
7	Genital diseases group	2	6.1
8	Neurasthenia, painless weakness diseases group	2	6.1
9	Bone pain, bone joint diseases group	9	27.3
10	Skin diseases group	14	42.4
11	Injured diseases group	7	21.2
12	Gynaecological diseases group	8	24.2
13	Children diseases group	4	12.1

### 3.5.2. Diversity of parts used of medicinal plant

The parts of medicinal plants used for treatment are presented in the following table.

**Tab. 3.5. Diversity of parts used of medicinal plant**

N0	Parts used	Number of species	Ratio % per total
1	Leaf	18	54,55
2	Stems, branches, bark of stem	16	48,48
3	All of plant	4	12,12
4	Root	18	54,55
5	Fruit	6	18,18
6	Flower, flower buds	3	9,09
7	Seed	10	30,30
8	Latex	4	12,12

### 3.5.3. Diversity of life form of medicinal plant

Their highlight is woody plant species, so 21/33 species have medicinal value, using 63.63% of the total number of medicinal plant species. The next by shrub species with 7 species, the number herbaceous species are used in a small proportion, only 3 species, the least is climbing species with 2 species.

### 3.5.4. Initial testing of antioxidant and cytotoxic activity from the stem of *Commersonia bartramia* (L.) Merr.)

Determination of chemical structures of isolated compounds: determined the structures of 8 isolated compounds: helichryoside-3'-methyl ether (1), tiliroside (2), pinoresinol (3), ursolic acid (4), quercetin (5), kaempferol (6), vanillic acid (7) and 4-hydroxybenzoic acid (8). Notably, there are 3 compounds pinoresinol (3), quercetin (5), kaempferol (6) isolated for the first time from the *Commersonia bartramia*.

Biological activity test: Among the newly isolated compounds, quercetin (5) showed good antioxidant activity (DPPH' RSA) with an EC<sub>50</sub> value of  $11.43 \pm 0.95 \mu\text{g/mL}$ , stronger than the control compound is resveratrol; moderately cytotoxic to cancer cell lines with IC<sub>50</sub> values from  $43.64 \pm 3.63$  to  $61.58 \pm 5.54 \mu\text{g/mL}$  (A549:  $43.64 \pm 3.63 \mu\text{g/mL}$ ; HepG2:  $55.25 \pm 3.88 \mu\text{g/mL}$ ; MCF7:  $61.58 \pm 5.54 \mu\text{g/mL}$ ).

Total extract MeOH, (+)-pinoresinol (3) and kaempferol (6) had moderate antioxidant activity, with EC<sub>50</sub> values of  $54.27 \pm 2.45 \mu\text{g/mL}$ ,  $63.14 \pm 3.59 \mu\text{g/mL}$ , and  $59.29 \pm 3.54 \mu\text{g/mL}$ ; weak cytotoxic activity against the HepG2 cancer cell line with IC<sub>50</sub> values of  $116.42 \pm 5.96 \mu\text{g/mL}$ ,  $> 128 \mu\text{g/mL}$ ,  $> 128 \mu\text{g/mL}$ ; weak cytotoxic activity against MCF7 cancer cell line with IC<sub>50</sub> values of  $107.96 \pm 8.23 \mu\text{g/mL}$ ,  $> 128 \mu\text{g/mL}$ ,  $> 128 \mu\text{g/mL}$ ; weak cytotoxic activity against the A549 cancer cell line with IC<sub>50</sub> values of  $106.09 \pm 4.74 \mu\text{g/mL}$ ,  $> 128 \mu\text{g/mL}$ ,  $> 128 \mu\text{g/mL}$ , respectively.

**Tab. 3.8. Cytotoxic and antioxidant effects of extract and isolated compounds**

STT	Extract and isolated compounds	IC <sub>50</sub> (μg/mL)			EC <sub>50</sub> (μg/mL)
		HepG2	MCF7	A549	DPPH' RSA
1	quercetin (5)	$55,25 \pm 3,88$	$61,58 \pm 5,54$	$43,64 \pm 3,63$	$11,43 \pm 0,95$



2	(+)-pinoresinol (3)	>128	>128	>128	63,14 ± 3,59
3	kaempferol (6)	>128	>128	>128	50,29 ± 3,54
4	MeOH	116,42 ± 5,96	107,96 ± 8,23	106,09 ± 4,74	54,27 ± 2,45
Ellipticine		0,40 ± 0,03	0,32 ± 0,02	0,42 ± 0,04	-
Resveratrol		-	-	-	13,39 ± 0,86

The biological activity data and medicinal plant information of *Commersonia bartramia* provide an important scientific basis for the future application of this species.

## CONCLUSION AND RECOMMENDATIONS

### Conclusion:

The process of researching the taxonomy and medicinal value of the Sterculiaceae Vent. family in Vietnam give out the following main conclusions:

1. Based on the views of Y. Tang, G. G. Michael & J. D. Laurence. (2008) to arrange taxa of the Sterculiaceae family in Vietnam. Accordingly, the Sterculiaceae Vent. family is a separate family taxon, the classification position of the Sterculiaceae Vent. family: belongs to the order Malvales, phylum Magnoliophyta. Up to now, the Sterculiaceae family in Vietnam with 4 subfamilies are recorded, with 23 genera and 87 species and subspecies.
2. Contributed to publishing 03 new species for scientific knowledge as *Sterculia konchurangensis* C.N.Kieu, D.B.Tran & B.H.Quang, *Helicteres taynguyenensis* V.S.Dang, Vuong & Naiki and *Helicteres dakmilensis* V. S. Dang, Vuong & Bao.
3. Described the morphological characteristics of taxa of the Sterculiaceae Vent. family in Vietnam; Build identification dichotomus keys for 4 subfamilies, 23 genera and 87 species of the Sterculiaceae Vent. family currently known in Vietnam based on morphological characteristics. Some important characteristics are bisexual or monosexual flowers, shallow or deep serrate of sepals, presence or absence of gynostemium and petals, style characteristics.

4. The Sterculiaceae family has 33 species recorded as medicinal plants. Among them, the number of species with leaves or root used as medicinal plants accounts for the most with 18 species. The number of species that treat digestive diseases accounts for the largest proportion, including 17 species.
5. About antioxidant and cytotoxic activity from the stem of *Commersonia bartramia* (L.) Merr.: Quercetin (5) has good antioxidant activity with an EC<sub>50</sub> value of  $11.43 \pm 0.95 \mu\text{g/mL}$ ; cytotoxic activity against tested cancer cell lines, the strongest against lung cancer cell line A549 with IC<sub>50</sub> of  $43.64 \pm 3.63 \mu\text{g/mL}$ . Total extract MeOH, (+)-pinoresinol (3) and kaempferol (6) had moderate antioxidant activity with EC<sub>50</sub> of  $54.27 \pm 2.45 \mu\text{g/mL}$ ,  $63.14 \pm 3.59 \mu\text{g/mL}$ , respectively. mL and  $50.29 \pm 3.54 \mu\text{g/mL}$ ; weak cytotoxic activity.

### **Recommendations**

Further research on molecular biological data is needed to help the process of building phylogenetic trees and the degree of closeness of taxa to find out the taxonomic position of taxa in the Sterculiaceae family; Research on biological activities of other species of the Sterculiaceae family.

### **NEW CONTRIBUTIONS OF THE THESIS**

1. Up to now, this is a complete and systematic research publication on the taxonomy of the Sterculiaceae Vent. family in Vietnam. Based on the views of Y. Tang, G. G. Michael & J. D. Laurence. (2008) to arrange taxa of the Sterculiaceae family in Vietnam. Accordingly, 4 subfamilies are recorded, with 23 genera and 87 species and subspecies.

2. Contributed to publishing 03 new species for scientific knowledge as *Sterculia konchurangensis* C.N.Kieu, D.B.Tran & B.H.Quang, *Helicteres taynguyenensis* V.S.Dang, Vuong & Naiki and *Helicteres dakmilensis* V. S. Dang, Vuong & Bao.

3. Provided scientific data on biological activities from the stem of *Commersonia bartramia*. Quercetin (5) has good antioxidant activity with an EC<sub>50</sub> value of  $11.43 \pm 0.95 \mu\text{g/mL}$ . Quercetin (5) also showed the strongest cytotoxic activity against the A549 lung cancer cell line with an IC<sub>50</sub> of  $43.64 \pm 3.63 \mu\text{g/mL}$  compared to the tested cancer cell line Hep. -G2 and MCF-7.

**LIST OF THE PUBLICATIONS RELATED TO THE  
DISSERTATION**

1. **Kieu Cam Nhung**, Nguyen Thi Phuong Anh, Do Thi Xuyen, *Phân loại các loài thuộc chi Thoa la (Reevesia Lindl.) ở Việt Nam*, Báo cáo khoa học - Hội nghị khoa học Quốc gia về nghiên cứu và giảng dạy sinh học ở Việt Nam lần thứ 4, 2021, 376-383.
2. **Kieu Cam Nhung**, Ha Thi Hang, Nguyen Anh Duc, Do Thi Xuyen, *Đặc điểm hình thái, giải phẫu của loài Tai mèo (Abroma augustum (L.) L. F. ở Việt Nam* - Hội nghị khoa học Quốc gia về nghiên cứu và giảng dạy sinh học ở Việt Nam lần thứ 5, CB28, 2022.
3. **Kieu Cam Nhung**, Le Ngoc Han, Vu Thi Hue, Do Thi Xuyen, Tran The Bach, *Nghiên cứu mối quan hệ gần gũi của các chi thuộc họ Trôm (Sterculiaceae) ở Việt Nam bằng ứng dụng phần mềm tin học và thông tin trình tự gen* - Hội nghị khoa học Quốc gia về nghiên cứu và giảng dạy sinh học ở Việt Nam lần thứ 5, CB36, 2022.
4. Van Son Dang, Ba Vuong Truong, Nghia Son Hoang, Van Tu Nguyen, Quoc Bao Nguyen, Quoc Trong Pham, Van Tho Le, **Cam Nhung Kieu**, Van Huong Bui, Akiyo Naiki, *Two new species of genus Helicteres (Helicteroideae, Malvaceae) from Viet Nam*, Academia journal of Biology, 2022, 123–132.
5. **Cam Nhung Kieu**, Duc Binh Tran, Ngoc Han Le, Thi Hoan Duong, Thu Ha Bui, Thu Thuy Nguyen, Hong Quang Bui, The Bach Tran. *A new species of Sterculia (Malvaceae) from Vietnam*, PhytoKeys, 227, 2023, 1-8.
6. **Kieu C. Nhung**, Tran T. Bach, Vu T. Hue, Bui T. Ha, Le N. Thanh, *Chemical Constituents and Biological Activities of Commersonia bartramia Stems*, Tropical Journal of Natural Product Research, 2023, 3147-3152.