MINISTRY OF EDUCATION AND TRAINING

VIETNAM ACADEMY OF SCIENCE AND TECHNOLOGY

**GRADUATE UNIVERSITY OF SCIENCE AND TECHNOLOGY**


**Tran Duc Binh**

# STUDY ON THE DIVERSITY OF VASCULAR PLANTS AND PROPOSED CONSERVATION SOLUTIONS AT KON CHU RANG NATURE RESERVE, GIA LAI PROVINCE

**SUMMARY OF DISSERTATION ON BIOLOGY**

**Major:** Botany

**Code**: 9.42.01.11

**Ha Noi - 2026**

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

Supervisors:

1. Supervisor 1: Assoc. Prof. Dr. Bui Hong Quang, Institute of Biology, Vietnam Academy of Science and Technology (VAST)
2. Supervisor 2: Dr. Nguyen The Cuong, Institute of Biology, Vietnam Academy of Science and Technology (VAST)

Referee 1: Assoc. Prof. Dr. Le Thi Thanh Huong, Thai Nguyen University of Sciences.
Referee 2: Dr. Tran Thi Phuong Anh, Graduate University of Science and Technology, Vietnam Academy Science and Technology.

The dissertation is examined by Examination Board of Graduate University of Science and Technology, Vietnam Academy of Science and Technology at 9:00 a.m. on 06 May 2026.

**This doctoral thesis can be found at:**
1. Graduate University of Science and Technology Library
2. National Library of Vietnam

# INTRODUCTION

## 1. Rationale for the study

Vietnam, characterized by a tropical monsoon climate, provides favorable conditions for the development of biological communities, contributing to a high level of biodiversity (BD). Biodiversity plays a crucial role in sustaining life, promoting socio-economic development, and protecting the environment. However, global biodiversity is currently under severe pressure from human activities such as overexploitation of natural resources, environmental pollution, climate change, and population growth, leading to an accelerating rate of species extinction. In response to this situation, biodiversity conservation has become a major global strategy, with the involvement of numerous international organizations in inventorying, assessing, protecting, and sustainably developing biological resources toward sustainable development.

In Vietnam, botanical research, particularly studies on forest plant resources, is one of the priority tasks in biodiversity conservation. Such research not only helps to identify and assess plant diversity in different regions but also supports the sustainable exploitation and use of plant resources. Moreover, the restoration and regeneration of plant populations to adapt to environmental changes play an important role in maintaining ecological functions and safeguarding the stability of natural ecosystems.

Kon Chu Rang Nature Reserve, which is part of the Kon Ha Nung Biosphere Reserve system, plays a particularly important role in biodiversity conservation and ecological protection. This reserve harbors significant biodiversity potential, especially in terms of plant diversity and evergreen forest ecosystems. However, to date, botanical studies in the area remain limited and are mainly statistical in nature, serving conservation planning purposes; no comprehensive and systematic study has yet been conducted. For this reason, the author undertook the dissertation entitled: "*Study on the diversity of vascular plants and proposed conservation solutions at Kon Chu Rang Nature Reserve, Gia Lai Province.*"

## 2. Research objectives

To assess the diversity of vascular plants at Kon Chu Rang Nature Reserve, Gia Lai Province.

To identify the causes of plant diversity decline and propose conservation solutions for plant diversity in the study area.

**3. Research contents**

3.1. Content 1: Identification and updating of the checklist of vascular plant species at Kon Chu Rang Nature Reserve, Gia Lai Province

To comprehensively and systematically update the list of vascular plant species at Kon Chu Rang Nature Reserve, Gia Lai Province.

3.2. Content 2: Assessment of vascular plant diversity at Kon Chu Rang Nature Reserve, Gia Lai Province

- Diversity of taxa at the levels of division, family, genus, and species;
- Diversity of plant life forms;
- Diversity of phytogeographical elements;
- Diversity of plant use values;
- Diversity of endangered, rare, and threatened genetic resources.

3.3. Content 3: Causes of decline and proposed conservation measures for plant diversity at Kon Chu Rang Nature Reserve, Gia Lai Province

**4. Scientific and practical significance**

*Scientific significance*

Updating and supplementing data on vascular plant diversity at Kon Chu Rang Nature Reserve, contributing to a clearer understanding of the plant species composition of the area.

Assessing diversity at different taxonomic levels (division, class, family, genus, species), as well as diversity in life forms, phytogeographical elements, and use values of plant species in the study area.

Establishing a checklist and distribution maps of endangered and rare plant species, and proposing conservation and sustainable development solutions for the flora of the reserve.

*Practical significance*

Providing a scientific basis for the development of an integrated conservation strategy and sustainable development of the flora at Kon Chu Rang Nature Reserve.

Supporting management agencies and scientists in conservation planning and prioritizing the protection of plant species with high scientific and economic value.

Contributing to raising awareness of plant resource conservation and proposing effective management measures to maintain biodiversity in the area.

**5. Novel contributions of the dissertation**

Providing a comprehensive overview of vascular plant diversity at Kon Chu

Rang Nature Reserve, with 1,288 species and infraspecific taxa, belonging to 652 genera and 163 families within five divisions of vascular plants.

Co-authoring and formally describing three new species to science: *Meistera muriformis*, *Sterculia konchurangensis*, and *Ceriscoides glabra*.

Recording one genus new to the flora of Vietnam, *Melanochyla*, and five species newly added to the flora of Vietnam: *Euphorbia bokorensis*, *Hedyotis diversifolia, Lasianthus latifolius, Glochidion geoffrayi, and Lysimachia nutantiflora.*

Proposing priority-based conservation measures for endangered and rare plant species using 20 priority criteria out of a total of 47 criteria, providing a scientific basis for species conservation and biodiversity conservation at Kon Chu Rang Nature Reserve.

**6. Structure of the dissertation**

The dissertation comprises 149 pages, including 48 tables, 20 figures, and 44 pages of photographs.

The structure of the dissertation is as follows: Introduction (3 pages); Chapter 1. Literature review (39 pages); Chapter 2. Study objects and methods (11 pages); Chapter 3. Results and discussion (72 pages); Conclusions and recommendations (1 page); List of publications related to the dissertation (2 pages); References (21 pages); Appendices**.**

## CHAPTER 1. RESEARCH OVERVIEW

### 1.1. Studies on plant diversity worldwide

#### 1.1.1. Studies on floristic diversity worldwide

Plant resources are invaluable assets of humankind, characterized by high richness and diversity, with an estimated 500,000–600,000 species of higher plants worldwide. Botanical research has been conducted since the early stages of human history.

The development of botany spans multiple historical periods, from early descriptive works to modern scientific foundations. During the Ancient and Medieval periods, plant studies were primarily based on morphology and medicinal uses, with notable scholars such as Theophrastus (Historia Plantarum, approximately 500 species), Pliny the Elder (Naturalis Historia, 37 volumes), and Dioscorides (De Materia Medica, over 600 species). In the Renaissance period (15th–17th centuries), botany developed in a more scientific and systematic direction, marked by the works of Leonhart Fuchs (De Historia Stirpium, 1542), Andrea Cesalpino (De Plantis Libri

XVI, 1583), and John Ray (Historia Plantarum, 1686–1704, approximately 18,000 species).

The 18th and 19th centuries represented a period of systematization in botany, with Carl Linnaeus proposing binomial nomenclature in Species Plantarum (1753) and Augustin de Candolle developing the natural classification system (Théorie Élémentaire de la Botanique, 1813), marking a transition from fragmented descriptions to analyses of natural relationships among plant species.

From the 20th century to the present, modern botany has advanced rapidly due to molecular biotechnology and bioinformatics. DNA sequences such as rbcL, matK, and ITS have been widely used to analyze phylogenetic relationships, leading to the establishment of molecular systematics. International working groups such as PPG (2016) and APG (2016) have developed updated classification systems for ferns, lycophytes, and flowering plants based on genetic data. In parallel, global databases including Plants of the World Online, World Flora Online, GBIF, IPNI, and Tropicos, along with projects led by the Royal Botanic Gardens, Kew, have strongly supported botanical research, conservation, and global plant science development.

At present, scholars such as Hutchinson, Takhtajan, and Heywood continue to refine natural and phylogenetic classification systems by integrating morphological, anatomical, and genetic data. Globally, there are approximately 452 families, 13,467 genera, and over 308,000 species of vascular plants, with angiosperms being dominant. However, many species are facing extinction threats due to habitat loss, overexploitation, invasive species, and climate change. Large-scale phylogenetic studies, such as Phylogenomics and the rise of the angiosperms, have clarified relationships among flowering plant lineages, opening new directions for evolutionary research and modern biodiversity conservation.

**1.1.2. Studies on flora in countries neighboring Vietnam**

In the Indochina–Malesia region, countries neighboring Vietnam have established robust botanical research systems. China, through Flora Reipublicae Popularis Sinicae and Flora of China, has recorded more than 31,000 species. Laos, via Flora of Laos and surveys in areas such as Nam Ha and Phou Khao Khouay, has documented over 5,000 species. Cambodia, through the works of Toyama and Rundel & Middleton, has recorded more than 1,100 species. Thailand, with Flora of Thailand and related projects, has documented over 6,700 species. The Malesian region, through Flora Malesiana, has recorded more than 12,400 species. Malaysia,

via Flora of Peninsular Malaysia and Tree Flora of Sabah and Sarawak, has documented over 8,300 species, while Myanmar has recorded more than 11,800 angiosperm species. These studies have established checklists, databases, new species descriptions, and endemism assessments, providing an important foundation for comparison and conservation planning of plant diversity in Vietnam.

**1.1.3. Studies on plant life-form diversity**

Plant life forms reflect survival strategies and adaptive capacities to climatic, edaphic, and ecological conditions. Raunkiaer's system (1934) classified plants into Phanerophytes (Ph), Chamaephytes (Ch), Hemicryptophytes (He), Cryptophytes (Cr), and Therophytes (Th) based on the position of perennating buds. Later models, such as those proposed by Grime (1979) and Box (1981), integrated ecological strategies and climatic factors.

Studies across different ecological regions show that life-form composition varies with environmental conditions (e.g., Therophytes dominate in the Cerrado and northeastern Brazil; Chamaephytes and Hemicryptophytes are common in Middle Eastern deserts; Hemicryptophytes prevail in the Mediterranean region and the Alps). These findings confirm that life forms serve as important ecological indicators, providing a basis for vegetation structure analysis, environmental impact assessment, and biodiversity conservation planning.

**1.1.4. Studies on phytogeographical elements and endemism**

Phytogeographical factors play a decisive role in the formation and distribution of flora, particularly endemic species. Numerous studies have shown that biodiversity hotspots, although covering only 1.4% of the Earth's land surface, contain up to 44% of vascular plant species. Countries such as Greece, Pakistan, and India exhibit high levels of plant endemism, while Southeast Asia is considered a global biodiversity center but is under severe pressure from deforestation.

In China, Exianling Mountain (Hainan) and the Hulun Buir region are notable examples illustrating the influence of topography and climate on endemism and species distribution. According to Middleton (2019), Southeast Asia currently records approximately 50,000 flowering plant species, though the actual number may be higher due to the continuous discovery and description of new endemic species.

**1.1.5. Studies on endangered and rare plant species**

The IUCN Red List of Threatened Species, first published in 1964, is the most

comprehensive global system for assessing extinction risk. Since 1994, IUCN has applied revised criteria classifying species into categories: Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), and Least Concern (LC). According to recent updates, more than 8,300 plant species have been assessed, many of which are experiencing severe declines due to habitat loss, overexploitation, and climate change.

In addition to the IUCN Red List, many countries have developed national Red Lists to conserve rare and threatened plant species. In Europe, countries such as Germany and Russia, as well as the European Union, maintain national and regional lists encompassing tens of thousands of threatened species. In Asia, India and Japan have established domestic assessment systems based on IUCN criteria, while China has completed the China Plant Red List, assessing over 30,000 species, many of which fall into the CR and EN categories. Laos has also reviewed endangered plant species through cooperation with China and IUCN to support transboundary biodiversity conservation. In North America, the United States and Canada maintain threatened plant lists under national legislation and specialized agencies. In South America and Africa, countries such as Brazil, Argentina, and South Africa have assessed thousands of native plant species, focusing on regions of high biodiversity. In Oceania, Australia and New Zealand have issued lists of endangered plant species, contributing to the conservation of regional endemic floras.

### 1.2. Studies on plant diversity in Vietnam

#### 1.2.1. Overview of plant diversity in Vietnam

Research on the flora of Vietnam has attracted the attention of both domestic and international scientists since an early period. Early works such as Flora Cochinchinensis by João de Loureiro (1793), which documented approximately 1,000 species in southern Vietnam, and Flore forestière de la Cochinchine by Jean Baptiste Louis Pierre (1880–1888) laid the foundation for Vietnamese botany in the nineteenth century. Subsequently, Flore générale de l'Indo-Chine, edited by Lecomte, described thousands of species across the Indochinese Peninsula and became an important taxonomic reference throughout the twentieth century. The series Flore du Cambodge, du Laos et du Vietnam (1960–2025), comprising 37 volumes, has provided detailed descriptions of vascular plant families of the three Indochinese countries.

In Vietnam, several landmark studies have been published, including Thai Van

Trung (1978), who recorded 7,004 species; Cây cỏ thường thấy ở Việt Nam by Le Kha Ke (1969–1976); and the comprehensive works of Pham Hoang Ho, namely Cây cỏ miền Nam Việt Nam and Cây cỏ Việt Nam (1999–2000), which documented up to 11,611 species. The series Cây gỗ rừng Việt Nam published by the Forest Inventory and Planning Institute (1971–1988) also made a significant contribution. Other authors, such as Phan Ke Loc (1970) and Nguyen Tien Ban (1997), further expanded knowledge of plant family and genus composition.

The Checklist of Plant Species of Vietnam (Volumes 1–3) has served as a standardized and systematic reference, documenting more than 10,780 angiosperm species. More recent studies by Le Tran Chan et al. recorded 10,192 species belonging to 2,298 genera and 285 families, while A Checklist to the Plants of Northern Vietnam (2022) identified 5,267 vascular plant species in northern Vietnam. In addition, major monographs and floristic works such as Flora of Vietnam (2000–2017), comprising 21 volumes, have provided detailed descriptions of thousands of species by family.

Specialized studies on particular plant groups, including orchids (Tran Hop; Averyanov et al.), Euphorbiaceae (Nguyen Nghia Thin), and taxonomic syntheses by Luu Dam Ngoc Anh et al., have clarified family–genus relationships under modern classification systems. In applied research, important compilations such as Checklist of Medicinal Plants of Vietnam (2016), Dictionary of Medicinal Plants of Vietnam by Vo Van Chi, Ornamental Plant Resources of Vietnam (Tran Hop, 2012), and studies on useful plants (Joongku Lee, Sangmi Eum et al.) have systematized plant resources for medicinal, economic, and conservation purposes. During the period 2020–2024, Vietnam recorded an additional 470 newly described plant species, indicating that the national flora still holds substantial potential for further research, documentation, and conservation.

**1.2.2. Overview of plant diversity across eight ecological regions**

Studies on the flora of Vietnam have been conducted across all eight ecological regions, revealing high levels of diversity and marked regional differentiation. In the Northeast region, numerous studies have recorded species numbers ranging from over 600 to more than 2,000 species in areas such as Sa Pa – Phan Si Pan, Na Hang, Phia Oac – Phia Den, Xuan Son, and Yen Tu, with high family richness and many valuable medicinal plants. The Northwest region, including Son La, Hoa Binh, Ta Xua, and Xuan Nha, has recorded approximately 500–1,000 species, reflecting the

diversity of forest vegetation recovering after shifting cultivation.

In the Red River Delta, national parks such as Cuc Phuong, Ba Vi, Tam Dao, and Xuan Thuy have recorded between 900 and over 2,000 species, including many mangrove plants and medicinal species with notable bioactive properties. The North Central region represents the most diverse area, with sites such as Pu Luong, Xuan Lien, Pu Hoat, and Pu Mat harboring more than 1,400–2,400 species, including numerous species new to science. In the South Central region, areas such as Hon Ba, An Toan, and forests of Khanh Hoa Province have recorded approximately 700–750 species, many of which are rare and threatened.

The Central Highlands constitute a major biodiversity center with over 3,000 species, particularly in national parks such as Bi Doup – Nui Ba, Chu Yang Sin, Kon Ka Kinh, and Kon Chu Rang, where thousands of plant species, numerous endemics, and valuable medicinal plants have been documented. The Southeast region (Cat Tien, Bu Gia Map, Binh Chau – Phuoc Buu, Con Dao, Dong Nai) supports 700–1,600 species, with a high proportion of timber, medicinal, and ornamental plants. Finally, the Mekong Delta, characterized by mangrove ecosystems in areas such as Ca Mau, U Minh, and Phu Quoc, has recorded between 40 and 1,300 species, including true mangrove species and traditional medicinal plants.

**1.2.3. Studies on plant life-form diversity**

Numerous studies on life-form spectra in Vietnam have demonstrated that plant life forms reflect natural conditions and regional adaptation. Life-form composition is commonly expressed as percentages of different life-form groups, providing insights into ecological characteristics and enabling comparisons among regions. For example, in Pu Luong and Pu Hoat Nature Reserves, trees and shrubs dominate, reflecting a well-developed woody vegetation layer; in the Sa Pa – Phan Si Pan area, life forms characteristic of high-mountain vegetation prevail; while in Son La, life-form spectra indicate secondary vegetation following shifting cultivation.

Most studies are based on Raunkiaer's system (1934), with certain modifications, helping to clarify morphological–ecological relationships and providing a basis for comparative evaluation of floras across ecological regions.

**1.2.4. Studies on phytogeographical elements and endemism**

Studies on phytogeographical elements in the Vietnamese flora are often conducted in conjunction with life-form analyses to elucidate relationships between species distribution and geographical origin. Le Tran Chan (1999) classified 10,193

species into 20 phytogeographical elements, of which four reflect regional endemism: Northern Vietnam, Central Vietnam, Southern Vietnam, and Vietnam endemics. In contrast, Nguyen Nghia Thin (2007) grouped endemic species into a single category, “Vietnam endemic”.

Research in Pu Luong Nature Reserve showed that tropical species dominate (68.4%), with Asian tropical species accounting for 60.52%, alongside a high proportion of endemic and near-endemic species (23.65%), reflecting strong affinities with the Indochinese and continental Asian floras. In Pu Hoat Nature Reserve, out of 2,425 vascular plant species, 2,409 species had clearly identified phytogeographical origins, with only 16 species lacking sufficient information, indicating a high level of completeness and reliability of geographical distribution data.

**1.2.5. Studies on endangered and rare plant species**

Research and legal frameworks related to the conservation of endangered, rare, and valuable plant species in Vietnam have shown substantial development in both scientific and management aspects. The Vietnam Red Data Book (Plants) has been compiled and updated several times: 356 species were listed in 1996, increasing to 450 species in 2000, 448 species in 2007, and expanding to 656 species by 2024, of which angiosperms account for 552 species. This progression reflects improvements in inventory work and assessment based on updated IUCN criteria.

From a legal perspective, the management system for threatened species has been gradually strengthened through instruments such as the Law on Biodiversity (2008), the Law on Forestry (2017), and decrees including 160/2013, 64/2019, and 84/2021, as well as Circular 85/2025/TT-BNNMT, the most recent and comprehensive regulation. This circular provides detailed provisions for classification, protection, conservation, exploitation, and cultivation of species based on IUCN and CITES criteria. Overall, these studies and regulations demonstrate Vietnam’s strong commitment to conserving rare, endemic, and biologically and medicinally valuable plant species, aiming toward sustainable use and long-term biodiversity conservation.

**1.3. Studies on the flora of Kon Chu Rang Nature Reserve**

To date, no comprehensive study has been conducted on the diversity of the flora at Kon Chu Rang Nature Reserve. Existing references mainly consist of scientific articles, technical reports, and master’s theses, most of which focus on the

description of species new to science or new records for the flora of Vietnam.

Since 2015, more than 20 plant species new to science have been recorded at Kon Chu Rang Nature Reserve, belonging to various plant families, clearly reflecting the high diversity and uniqueness of the local flora. Specifically, *Capparis gialaiensis* (Capparaceae) was described in 2015; *Premna vietnamensis* (Lamiaceae) in 2018; *Anadendrum chlorospathum* (Araceae), *Boeica konchurangensis* (Gesneriaceae), and *Aspidistra minor* (Asparagaceae) in 2019; *Psydrax gialaiensis* and *Lasianthus konchurangensis* (Rubiaceae), together with *Peliosanthes crassicoronata* (Asparagaceae), in 2020; *Rungia gialaiensis* (Acanthaceae) in 2021; *Typhonium kbangense* (Araceae), *Aspidistra nikitensis* (Asparagaceae), *Lasianthus naikii, L. sonlangensis, L. gialaiensis,* and *L. kbange*nsis in 2022; and most recently, *Syzygium triflorum* (Myrtaceae) in 2025. Among these, the family Rubiaceae accounts for the highest number of newly described species, highlighting the considerable potential for the discovery and study of new taxa in the Kon Chu Rang area.

Despite these remarkable achievements in the discovery and description of new species, there has been no comprehensive assessment of species composition, structural characteristics, ecological features, or conservation values of the vascular plant flora at Kon Chu Rang Nature Reserve. Therefore, a holistic and in-depth study of the flora of this area is both necessary and timely.

### 1.4. Natural and socio-economic conditions of Kon Chu Rang Nature Reserve

#### 1.4.1. Natural conditions of Kon Chu Rang Nature Reserve

Kon Chu Rang Nature Reserve is located in Son Lang Commune, Gia Lai Province, approximately 70 km from Kbang Town, bordering Binh Dinh and Quang Ngai provinces. The reserve covers an area of 15,526,05 ha (comprising 14 sub-zones), is managed by the Gia Lai Department of Agriculture and Rural Development, and is referenced within the VN-2000 coordinate system.

The topography of the northeastern Kon Ha Nung area is characterized by elevations ranging from 900 to 1,000 m, consisting of medium mountains (58.3%), relatively flat plateaus (28.8%), and valleys (12.9%), where several large waterfalls occur, including the well-known K50 Waterfall. The climate exhibits transitional characteristics between the Northern Central Highlands and the South Central Coast, with two distinct seasons. The mean annual temperature ranges from 20 to 23°C, annual rainfall from 2,000 to 2,400 mm, and relative humidity averages

approximately 82%, creating favorable conditions for tourism, particularly during January–April and July–September.

The reserve lies in the headwaters of the Kon River, with three main stream systems—Say, Da, and Dak Phan—playing an essential role in water regulation and supply for downstream areas. Geologically, the area is dominated by ancient metamorphic rocks interbedded with basalt layers (10–100 m thick), with occurrences of bauxite. The combined effects of diverse topography and geological substrates have created a wide range of habitats with high biodiversity potential. Overall, Kon Chu Rang Nature Reserve possesses rich natural conditions, a cool and humid climate, and abundant water resources, providing critical habitats for many rare species and contributing significantly to watershed protection within the Kon River basin.

**1.4.2. Socio-economic conditions of Kon Chu Rang Nature Reserve**

The buffer-zone communes of Son Lang and Dak Roong have a total population of 8,377 people, of whom ethnic minorities—primarily the Ba Na—account for 67.4%, while the Kinh people represent 32.6%. The labor force comprises 6,483 individuals, most of whom are engaged in agriculture with relatively low incomes. Local livelihoods are mainly based on crop cultivation, small-scale livestock production, and the collection of non-timber forest products. The Ba Na ethnic group maintains a matrilineal social structure and rich traditional festivals, offering potential for cultural and community-based tourism. Meanwhile, coffee cultivation and service-based economic activities practiced by Kinh households have contributed to income improvement and crop diversification.

Basic education services generally meet local needs, while healthcare is provided through commune health stations, although access remains limited due to the distance from central facilities. Infrastructure, electricity supply, and telecommunications are still underdeveloped, particularly during the rainy season. Conservation efforts benefit from advantages such as an abundant labor force, extensive forest resources, and gradually improving infrastructure; however, challenges remain due to population growth, low household incomes, dependence on forest resources, and ongoing illegal activities such as logging, grazing, and wildlife hunting. Financial support and livelihood transformation programs are therefore needed to reduce pressure on forest resources.

Access to the reserve is relatively convenient via the Eastern Truong Son National Highway, although internal roads consist mainly of old forestry tracks and footpaths that require upgrading. Due to the mountainous terrain, waterway transportation is not feasible. The reserve provides key ecosystem services, particularly water regulation over more than 15,270 ha. Payments for forest environmental services (PFES) support forest protection and local livelihoods; however, other services such as carbon sequestration, landscape values, and ecotourism remain underdeveloped. Communities in the buffer zone continue to experience poverty and high dependence on forest resources.

**1.4.3. Current land-use status**

The total area managed by Kon Chu Rang Nature Reserve is 15,526.05 ha, including 15,425.43 ha within the three-category forest planning system and 100.62 ha outside the planning boundary. Natural forest land dominates (15,270.02 ha), followed by areas with regenerating woody vegetation (66.03 ha), bare land (58.19 ha), agricultural land (12.82 ha), and other land uses (18.37 ha). Land outside the planning area mainly consists of rivers and streams (91.91 ha) and administrative facilities (8.71 ha).

Overall, land use within the reserve is relatively stable, with minimal forest area change and increasing timber volume due to the absence of commercial logging. Nevertheless, management capacity remains limited and largely dependent on state budgets. Ecotourism development has been slow, and infrastructure remains insufficient to meet conservation requirements. During the 2021–2030 period, priority should be given to infrastructure investment to enhance management effectiveness and fully realize the conservation and sustainable use potential of the reserve.

**1.4.4. Current status of forest resources**

Kon Chu Rang Nature Reserve encompasses 15,526,05 ha of forest and forestry land, predominantly consisting of secondary evergreen and semi-deciduous broadleaf forests. Rich forests cover approximately 10,700 ha, with an estimated timber volume of 3.48 million $m^3$, and include diverse tree species such as Michelia, Castanopsis, Peltophorum, Madhuca, Canarium, and Dipterocarpus. Medium-quality forests occupy about 4,370 ha with a timber volume of 841,300 $m^3$, dominated by species such as Michelia, Castanopsis, Peltophorum, Cinnamomum, Litsea, and Dialium. Poor forests account for approximately 199 ha, with a timber

volume of 19,415 $m^3$, where species such as Michelia, Castanopsis, Litsea, and Dialium remain present.

## CHAPTER 2. STUDY OBJECTS, CONTENTS, AND RESEARCH METHODS

### 2.1. Study objects and scope

Higher plants within the boundaries of Kon Chu Rang Nature Reserve.

Study period: three years, from May 2022 to May 2025.

### 2.2. Research contents

- Compilation of a checklist of vascular plant species at Kon Chu Rang Nature Reserve.
- Assessment of plant diversity, including:
  + Diversity of taxa at the levels of division, class, family, and genus;
  + Diversity of plant life forms;
  + Diversity of phytogeographical elements;
  + Diversity of use values;
  + Diversity of endangered, rare, and threatened genetic resources.
- Identification of causes and proposal of conservation measures for plant diversity.

### 2.3. Research methods

#### 2.3.1. Literature review method

Relevant documents related to the study area were collected and reviewed. Both published and unpublished materials on plant diversity at Kon Chu Rang Nature Reserve, Gia Lai Province, were inherited and utilized.

#### 2.3.2. Plant diversity research methods

Plant collection, classification, assessment, and identification were conducted following the botanical research methods proposed by Nguyen Nghia Thin (2007).

#### 2.3.3. Data processing and analysis methods

Collected voucher specimens were identified using comparative morphological methods, with reference to national and international floras, and were cross-checked against type and reference specimens housed in major herbaria worldwide (BM, A, C, E, K, MO, NY, P, LE, etc.). Nomenclature was revised in accordance with international rules and updated to the most recent standards.

The plant checklist was compiled based on the Checklist of Plant Species of Vietnam, with plant divisions arranged according to Takhtajan (2009). Species,

genus, and family names were updated following PPG I (2016) for ferns and lycophytes, GPG (2019) for gymnosperms, and APG IV for angiosperms. The checklist includes scientific names, Vietnamese names, phytogeographical elements, life forms, use values, and conservation status.

Taxonomic diversity was analyzed based on the numbers of families, genera, species, and infraspecific taxa within each division. The ten most diverse families and genera were identified, and diversity levels were compared with those of neighboring areas to evaluate the floristic position of the study area within the regional flora.

Phytogeographical elements were determined following the classification system of Nguyen Nghia Thin (2007) and updated according to Kew databases, comprising 16 groups ranging from cosmopolitan to Vietnam endemic elements. Life forms were analyzed using Raunkiaer's system, including categories such as phanerophytes, cryptophytes, hemicryptophytes, chamaephytes, and therophytes.

Use values of plant species were synthesized from various national and international sources (e.g., Pham Hoang Ho, Vo Van Chi, PROSEA) and classified according to the system of Diazgranados et al. (2020), which includes 10 use categories: AF, EU, FU, GS, HF, IF, MA, ME, PO, and SU, ensuring methodological modernity and international data compatibility.

Conservation status was assessed based on the Vietnam Red Data Book (2024), Circular No. 85/2025/TT-BNNMT, and the IUCN Red List (2019) accessed online in 2025. Distribution maps of endemic, rare, and threatened species were developed using remote sensing data, forest status maps, and the three-category forest planning system.

## CHAPTER 3. RESULTS AND DISCUSSION

### 3.1. Updated checklist of vascular plants in Kon Chu Rang Nature Reserve, Gia Lai Province

The checklist of vascular plants in Kon Chu Rang Nature Reserve was established based on field surveys combined with a synthesis of published data, applying current classification systems (PPG I, GPG, APG IV). The results recorded 1,288 species and infraspecific taxa belonging to 652 genera, 163 families, and 5 divisions. Among these, the authors and collaborators discovered and described three species new to science: *Meistera muriformis*, *Sterculia konchurangensis*, and *Ceriscoides glabra*. In addition, one genus new to the flora of Vietnam

(*Melanochyla*, Anacardiaceae) and five species newly recorded for Vietnam—*Euphorbia bokorensis*, *Hedyotis diversifolia*, *Lasianthus latifolius*, *Glochidion geoffrayi*, and *Lysimachia nutantiflora*—were documented. A total of 815 vascular plant species were supported by collected specimens or research photographs, with 315 specimen numbers collected within the reserve.

### 3.2. Floristic diversity of Kon Chu Rang Nature Reserve, Gia Lai Province

#### *3.2.1. Diversity at the division level*

The survey recorded 1,288 species and infraspecific taxa distributed among 652 genera, 163 families, and 5 divisions of vascular plants, including:

Lycopodiophyta: 6 species, 4 genera, 2 families;

Equisetophyta: 1 species, 1 genus, 1 family;

Polypodiophyta: 45 species, 30 genera, 9 families;

Pinophyta: 8 species, 5 genera, 2 families;

Magnoliophyta: 1,228 species, 612 genera, 149 families.

The flora of the study area is overwhelmingly dominated by angiosperms (Magnoliophyta), which account for 91.41% of families, 93.87% of genera, and 95.34% of species, reflecting the typical characteristics of tropical floras where flowering plants are dominant. The remaining divisions contribute only minor proportions.

Comparative analysis shows that Kon Chu Rang harbors approximately 73% of the total species recorded in Kon Ka Kinh National Park and 1.74 times more species than An Toàn Nature Reserve. Species similarity between areas is moderate to low, as indicated by the Sørensen index: 0.397 between Kon Ka Kinh and Kon Chu Rang, and 0.261 between An Toàn and Kon Chu Rang. This suggests a closer floristic relationship between Kon Chu Rang and Kon Ka Kinh, while An Toàn, despite its proximity, differs considerably due to variations in forest types, topography, and ecological conditions.

#### *3.2.2. Diversity at the family level*

The twelve most species-rich families represent only 7.36% of the total number of families but contain 498 species, equivalent to 38.66% of the total flora. Rubiaceae is the most diverse family with 104 species (8.07%), followed by Orchidaceae with 62 species (4.81%) and Lauraceae with 60 species (4.66%). Other families such as Fabaceae, Apocynaceae, Lamiaceae, and Primulaceae comprise 29–42 species, while Fagaceae, Symplocaceae, Annonaceae, Asteraceae, and

Malvaceae include approximately 26–28 species, highlighting the richness typical of tropical evergreen forests.

***3.2.3. Diversity at the genus level***

The eleven most diverse genera account for only 1.69% of all genera but include 190 species (14.74% of total species). Lasianthus (Rubiaceae) is the most diverse genus with 27 species, followed by Symplocos (26 species) and Litsea (20 species). Other genera such as Ficus, Ardisia, Syzygium, and Smilax also exhibit high species richness, contributing significantly to the floristic structure of the area.

***3.2.4. Diversity of life forms***

The life-form spectrum of the flora was established following Raunkiaer (1934) as modified by Nguyễn Nghĩa Thìn (2007):

SB = 90.14Ph + 2.33Ch + 2.02Hm + 2.48Cr + 3.03Th.

The phanerophyte group shows high diversity, with the following composition:

Ph = 18.87Mi + 12.58Me + 16.54Lp + 26.09Na + 4.74Ep + 4.74Mg + 5.67Hp + 0.85Pp.

***3.2.5. Diversity of phytogeographical elements***

The flora of Kon Chu Rang Nature Reserve exhibits high phytogeographical diversity, dominated by tropical elements, particularly Indochina–South China, Indochina–Malesia, Indochina–Himalaya, Indochina, Asian tropical, and pantropical elements. Among these, the Indochina–South China element is most prominent with 209 species (16.23%), followed by Indochina–Malesia (206 species, 15.99%) and Indochina–Himalaya (174 species, 13.51%).

A total of 130 endemic species were recorded (7.11% of the total flora), mostly belonging to Magnoliophyta (128 species), with only two species of ferns (Polypodiophyta). Of these, 113 species are endemic to Vietnam, and 17 species are restricted exclusively to Kon Chu Rang Nature Reserve.

***3.2.6. Diversity of use values***

The assessment results indicate that Kon Chu Rang Nature Reserve possesses a very high potential for plant utilization, with 886 out of 1,288 recorded species (nearly 69%) having use values, accounting for a total of 2,156 recorded use instances. The most prominent group is medicinal plants (ME), comprising 724 species (56.21%), highlighting the substantial potential for pharmaceutical research and medical applications. This is followed by material plants (MA) with 439 species (34.08%), plants used as human food (HF) with 256 species (19.88%), and plants

used for environmental purposes (EU) with 206 species (15.99%).

The remaining use groups, including animal food (AF), social uses (SU), poisons (PO), fuels (FU), gene sources (GS), and invertebrate food (IF), account for smaller proportions; nevertheless, they collectively reflect the diversity of uses and the ecological–economic value of the local flora. Animal food (AF): 55.83% of species; the most species-rich family is Poaceae (12 species), and the most diverse genus is *Ficus* (5 species); representative species include *Equisetum ramosissimum*, *Pteridium aquilinum*, and *Ficus racemosa*. Environmental uses (EU): 41.75% of species; the family Fabaceae is the most diverse (17 species), while *Ficus* is the most species-rich genus (5 species); representative species include *Imperata cylindrica*, *Saccharum spontaneum*, and *Ficus* spp. Fuels (FU): 49.43% of species; the most species-rich family is Meliaceae (6 species), and the most diverse genera are *Ficus*, *Trema*, and *Syzygium* (3 species each); representative species include *Melia azedarach*, *Trema orientale*, and *Ficus* spp. Gene sources (GS): 63.79% of species; the family Moraceae has the highest number of species (7), and *Ficus* is the most diverse genus (6 species); representative species include *Ficus racemosa*, *Solanum torvum*, and *Dioscorea cirrhosa*. Human food (HF): 40.23% of species; the most species-rich family is Asteraceae (17 species), and the most diverse genus is *Syzygium* (7 species); representative species include *Syzygium cumini*, *Centella asiatica*, and *Oenanthe javanica*. Invertebrate food (IF): 53.13% of species; Asteraceae is the most species-rich family (5 species), while genera are evenly represented with one species each (32 genera); representative species include *Ageratum conyzoides*, *Bidens pilosa*, and *Pluchea indica*. Materials (MA): 38.27% of species; Lauraceae is the most species-rich family (32 species), and the most diverse genera are *Elaeocarpus*, *Litsea*, and *Syzygium* (8 species each); representative species include *Cinnamomum burmanni*, *Calamus* spp., and *Ficus* spp. Medicinal plants (ME): 35.08% of species; Rubiaceae is the most species-rich family (54 species), and *Ardisia* is the most diverse genus (10 species); representative species include *Morinda citrifolia*, *Cinnamomum parthenoxylon*, and *Smilax* spp. Poisons (PO): 46.85% of species; Apocynaceae is the most species-rich family (9 species), and *Alstonia* is the most diverse genus (4 species); representative species include *Alstonia scholaris*, *Rauvolfia serpentina*, and *Thevetia peruviana*.

### *3.2.7. Diversity of endangered, rare, and precious genetic resources*

*3.2.7.1. Diversity of endangered, rare, and precious plant genetic resources based*

*on assessment criteria*

The flora of Kon Chu Rang Nature Reserve includes 135 threatened plant species belonging to 91 genera and 38 families, representing a considerable proportion of the total 1,288 species, 652 genera, and 163 families of vascular plants recorded in the study area.

According to the Vietnam Red Data Book (2024), 42 species are listed, including 3 Critically Endangered (CR), 14 Endangered (EN), and 25 Vulnerable (VU) species. The IUCN Red List (2025) records 41 species, comprising 9 CR, 17 EN, and 15 VU species. Meanwhile, Circular No. 85/2025 of the Ministry of Agriculture and Environment lists as many as 75 species subject to strict management, including 1 species in Group IA (strictly prohibited from exploitation) and 74 species in Group IIA (restricted exploitation).

Overall, these results indicate a high level of threat and emphasize the urgent need for strict conservation measures for numerous plant species within the study area.

*3.2.7.2. Basis for prioritizing species conservation according to four criteria*

Threat assessments of Vietnamese plant species are primarily conducted at the national level; therefore, domestic data sources—including the Vietnam Red Data Book (2024), Circular No. 85/2025 of the Ministry of Agriculture and Environment, and the list of Vietnamese endemic species—were given higher priority than the IUCN Red List (2025), which reflects global threat levels. Accordingly, a priority ranking of plant species in Kon Chu Rang Nature Reserve was proposed, with conservation priority levels ranging from 1 to 47.

**3.3. Causes of decline in plant diversity at Kon Chu Rang Nature Reserve**

The causes of forest resource degradation at Kon Chu Rang Nature Reserve can be classified into two main groups:

*Direct causes:*

Illegal logging has continued to occur (five cases recorded during 2016–2019). The harvesting of non-timber forest products, such as rattans, orchids, mushrooms, honey, and medicinal plants, is frequent. In addition, forest fires and the impacts of climate change— including prolonged heat, extreme cold events, and landslides— have adversely affected plant communities.

*Indirect causes:*

Poverty and lack of stable employment reduce local people’s active participation

in forest protection (average forest protection contracts provide only 7–8 million VND per household per year). Low education levels and traditional farming practices, inefficient agricultural production, and limitations in forest investment and allocation policies further exacerbate pressure on forest resources. Moreover, the forest ranger workforce remains limited in number, with uneven professional capacity, making it difficult to effectively control violations of forestry regulations.

*Advantages and constraints in plant diversity conservation*

*Advantages:*

Kon Chu Rang Nature Reserve has established a relatively effective forest management system, comprising three ranger stations, one mobile patrol team, and six forest protection checkpoints. Annually, approximately 277 patrols are conducted across 15,526 ha of forest. The application of SMART monitoring tools, camera traps, and close coordination with local authorities has contributed to the early detection and prevention of forestry law violations. Forest fire prevention and control (FFPC) activities are implemented on a 24-hour basis during the dry season, while awareness-raising campaigns have involved more than 400 local residents and students. In addition, the Management Board has allocated about 4,000 ha of forest for protection contracts to 329 households, and has promoted cooperation in scientific research, livelihood development, and the preparation of an ecotourism development plan.

*Constraints:*

The forest protection force remains understaffed (only 16 personnel) relative to the large area and complex terrain, while violations have become increasingly sophisticated. Limitations in communication infrastructure and inter-agency coordination increase risks in forest fire prevention and control. Furthermore, restricted staffing levels, insufficient specialized training, weak infrastructure, and limited conservation funding hinder management effectiveness. Investment policies for special-use forests and forest protection payments remain low, providing insufficient incentives for local communities to actively engage in forest conservation.

### 3.4. Proposed biodiversity conservation solutions for the flora of Kon Chu Rang Nature Reserve

#### 3.4.1. Proposed solutions for biodiversity conservation

Biodiversity conservation at Kon Chu Rang Nature Reserve is implemented

through an integrated approach that links nature conservation with sustainable development. Specifically:

- Landscape scale: Expansion and strengthening of the core and buffer zones (15,526 ha) under an integrated governance model combining forests, local communities, and sustainable development.

- Socio-economic aspects: Development of sustainable livelihoods, such as understory medicinal plant cultivation, small-timber plantations, and integrated garden–pond–livestock (VAC) farming systems.

- Landscape and ecological conservation: Maintenance of over 98% natural forest cover, strict protection of sub-compartments 36, 37, and 40, and establishment of landscape monitoring sites and environmental early-warning systems.

- Culture and indigenous knowledge: Documentation, transmission, and conservation of traditional knowledge; establishment of medicinal plant gardens and spiritual spaces; and integration of conservation with community-based tourism.

- Science and community engagement: Enhancement of public awareness through bilingual educational materials, implementation of the "Community-based forest stewardship" model, and application of modern technologies (SMART monitoring, GIS, camera traps) in forest management and habitat restoration.

### 3.4.2. Proposed solutions for the conservation and development of plant resources

Conservation at Kon Chu Rang is based on close coordination among the Nature Reserve Management Board, research institutes, enterprises, cooperatives, and local communities. Linking each plant-use group with appropriate organizations is expected to promote conservation outcomes associated with sustainable development.

### 3.4.3. Proposed solutions for the conservation of rare and threatened plant species

*Priority-based conservation solutions:*

Plant species are prioritized for conservation based on their threat status in the Vietnam Red Data Book (2024), the IUCN Red List (2025), Circular No. 85/2025 of the Ministry of Agriculture and Environment, and their level of endemism. Priority ranking follows a descending order: CR → EN → VU → endemic species → IA and IIA groups.

*In situ and ex situ conservation solutions:*

In situ conservation focuses on maintaining natural populations within sub-compartments 32–37 and 39–40, where forest cover exceeds 98%, supported by SMART monitoring tools, camera traps, and community participation.

Ex situ conservation includes the establishment of a 5–10 ha botanical garden for propagation and conservation, applying techniques such as seed germination, vegetative propagation, tissue culture, and experimental restoration in forest sub-compartments, household gardens, and greenhouse facilities.

## CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

- Updated checklist of vascular plant species at Kon Chu Rang Nature Reserve

+ A total of 1,288 vascular plant species belonging to 652 genera and 163 families across five divisions of vascular plants were recorded.

+ 815 species were directly collected and studied through voucher specimens or photographic records, including 315 herbarium specimen numbers collected by the doctoral candidate.

+ Three new species were jointly described for science; one new genus was newly recorded for the flora of Vietnam; and five species were newly added to the Vietnamese flora.

- Assessment of floristic diversity at Kon Chu Rang Nature Reserve

+ Life forms were identified for all 1,288 species, and a life-form spectrum of the flora was established.

+ Phytogeographical elements were determined for all species and classified into 16 geographical groups.

+ A total of 2,156 use records were documented, involving 886 species and infraspecific taxa with economic, medicinal, or environmental values.

+ A checklist and distribution maps of 135 endangered, rare, and threatened plant species belonging to 38 families and 91 genera were compiled and compared with existing databases: 42 species listed in the Vietnam Red Data Book (2024), 41 species in the IUCN Red List (2025), and 75 species listed in Circular No. 85/2025 of the Ministry of Agriculture and Environment.

- Proposed biodiversity conservation solutions

Five groups of integrated biodiversity conservation solutions were proposed, along with one model for the conservation and development of plant resources, and two targeted solutions for the conservation of endangered and rare plant species.

**Recommendations**

Continued research and policy refinement are recommended, alongside the implementation of specific measures to protect and develop forest resources at Kon Chu Rang Nature Reserve, promoting forest–garden economic models, community-based tourism, and ecological restoration activities.

Adoption of an “integrated and balanced approach” to biodiversity conservation is recommended to ensure harmony between resource utilization, sustainable use, and long-term conservation of plant diversity.

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

1. Tran Duc Binh, Bui Hong Quang, Nguyen The Cuong, Ha Quy Quynh, Duong Thi Hoan, Do Van Hai, Khang Sinh Nguyen & Maxim S. Nuraliev, 2022. Ceriscoides glabra (Gardenieae: Rubiaceae), a new species from Kon Chu Rang Nature Reserve, southern Vietnam. Phytotaxa, 574(2): 158–164.

2. Maxim S. Nuraliev, Hironori Toyama, Chi-Ming Hu, Shi-Xiao Luo, Dmitry F. Lyskov, Andrey N. Kuznetsov, Svetlana P. Kuznetsova, Bui Hong Quang, Tran Duc Binh & Duong Thi Hoan, 2022. Three new national records from Kon Chu Rang Nature Reserve, Vietnam: Euphorbia bokorensis, Glochidion geoffrayi and Lysimachia nutantiflora. Phytotaxa, 574(1): 73–82.

3. Tran Duc Binh, Bui Hong Quang & Trinh Ngoc Hiep, 2022. Diversity of medicinal plants belonging to Magnoliophyta with potential for treating rheumatism in Kon Chu Rang Nature Reserve, Gia Lai Province. Journal of Tropical Science and Technology, 30: 77–83. (in Vietnamese)

4. Ha Thi Dung, Phan Xuan Binh Minh, Vu Anh Thuong, Tran Duc Binh, Le Ngoc Han, Duong Thi Hoan & Ha Minh Tam, 2022. Diversity of the genus Lasianthus Jack (Rubiaceae) in Kon Chu Rang Nature Reserve and a new record for the flora of Vietnam. In: Proceedings of the 5th National Conference on Biological Research and Teaching in Vietnam, pp. 52–62. (in Vietnamese).

5. Cam Nhung Kieu, Tran Duc Binh, Le Ngoc Han, Duong Thi Hoan, Bui Thu Ha, Nguyen Thu Thuy, Bui Hong Quang & Tran The Bach, 2023. A new species of Sterculia (Malvaceae) from Vietnam. PhytoKeys, 227: 1–8.

6. Bui Hong Quang, Tran Duc Binh, Tran Thi Ngoc Diep, Tran Thi Thuy Duong & Le Tuan Anh, 2023. Typification and novelties in Rubiaceae for the flora of Vietnam. Academia Journal of Biology, 45(1): 11–21.

7. Jana Leong-Škorničková, Nguyen Quoc Binh, Tran Huu Dang, Eliška Záveská, Bui Hong Quang, Tran Duc Binh, Xing-Er Ye, Khang Sinh Nguyen, Andrey N. Kuznetsov, Svetlana P. Kuznetsova & Maxim S. Nuraliev, 2023. A key to Meistera (Zingiberaceae: Alpinioideae) in Cambodia, Laos and Vietnam, with the description of a new species, M. muriformis. Phytotaxa, 618(2): 149–160.

8. Tran Duc Binh, Bui Hong Quang, Vu Anh Thuong, Le Ngoc Han, Vu Ha Phuong, Nguyen Thi Thanh, Pham Duc Chinh & Nguyen Thu Thuy, 2024. Characteristics of medicinal plants belonging to Magnoliophyta with potential for infertility treatment

in Kon Chu Rang Nature Reserve, Gia Lai Province. Hung Vuong University Journal of Science and Technology, 37(4): 93–100.

9. Tran D.B., Bui H.Q., Nguyen T.C., Choudhary R.K. & Nguyen X.Q., 2024. Melanochyla (Anacardiaceae): a new generic record for the flora of Vietnam. Rheedea, 34(4): 225–231.