Which are the more important Magnolia species of Thailand, and what is their potential for hybridization with species hardy to Sweden?

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Abstract

The Magnoliaceae family represents one of the oldest lineages of flowering plants, with a rich evolutionary history spanning over 100 million years. Thailand is home to 27 native Magnolia species and offers unique and interesting opportunities for hybridization due to the diverse morphological, aesthetic, and genetic traits of its native species. This study explores the seemingly underused potential of Thai Magnolia species in hybridization with temperate varieties to enhance resilience, adaptability, and aesthetic diversity in horticulture. Through a combination of literature review, field observation, and semi-structured interviews, the study identifies key species suitable for hybridization based on genetic closeness, cultural significance, and aesthetic value thus providing knowledge for future hybridization with species hardy to Sweden and temperate regions.

The findings highlight genetic relationships between temperate magnolias and those native to Thailand providing practical findings and insights for magnolia breeders, landscape architects, conservationists and more, offering a foundation for future hybridization projects.

Foreword

I want to give thanks to a number of people and institutions but starting with MFS (SLU Global) and Karl Evert Flincks Magnoliafond for their financial support in conducting this study. My supervisor Anna Levinsson for being a person of great knowledge and support guiding me through the thesis. Khun Voradol Chamchumroon for taking me under his wings and introducing me to people of importance and taking me on unforgettable excursions. All staff at BKF for their helpfulness. Everyone at Vieng Dok Mai Hom garden. Peter Linder, Erland Ejder and Richard Figlar for their long time communication to me regarding Magnoliaceae.

Preface

The images used in this thesis are provided by the author, unless other sources have been mentioned. The permission to use these images has been given to the author by the original sources.

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Introduction

The Magnoliaceae family is one of the oldest still living groups of flowering plants (Hernández-Vera et al., 2021), with an evolutionary history that dates back over 100 million years (Kim et al., 2001). Its evolutionary significance has been supported by molecular studies, which trace its diversity and adaptation over geological time (Azuma, Thien & Kawano, 1999). Hernandez-Vera et al. (2021) presents the theory that the Magnoliaceae family made the early beetles shift hosts from gymnosperms to angiosperms and also stating the importance beetles have had in shaping the floral biology and morphology of Magnoliaceae by sheltering, mating and feeding in the flower structures of the *Magnolia*.
While magnolia trees are prized and often used in urban landscapes and gardens in Sweden (Hunt 1998) , research on integrating exotic species such as the magnolias native to Thailand into such climates is scarce or nonexistent. Thailand is home to 27 different native species of *Magnolia* across its diverse climatic zones and ecosystems (Nooteboom & Chalermglin, 2009). Conservation efforts for the Magnoliaceae family are crucial, as 131 species - more than half of the known taxa in the family, are threatened with extinction at a global scale (Nooteboom & Chalermglin, 2009). Therefore the opportunity to present candidates for future hybridization arises.

The 27 native species of Magnolia in Thailand exhibit unique morphological and aesthetic traits, including varied flower shapes, fragrances, and growth habits, making them promising candidates for hybridization with temperate varieties (Nooteboom & Chalermglin, 2009). Despite their potential, Thai Magnolia species remain underrepresented in horticultural and scientific literature outside Southeast Asia apart from two recognized successful hybrids (J.K Parris (2018)). Research by J.K Parris (2018) explored hybridization of several *Magnolia* species including *Magnolia insignis* which is one of the species native to Thailand that has shown suitability for hybridization with temperate magnolias. Insights gained from the work of J.K Parris (2018) highlights the importance of species selection when creating new hybrids. It showcases successful hybridization between the native to Thailand *M. insignis* and *M. sieboldii* which is one of the more common and most hardy (Mustila Arboretum n.d.). magnolias that are available for purchase in Sweden. His work has also demonstrated a successful crossing between *M. insignis* and *M. tripelata x obovata.* Studies such as those by Nooteboom and Chalermglin (2009) lists all 27 native species and provide foundational insights into Thai Magnolias but leave significant gaps in understanding their genetic relationships with temperate species and their adaptability to non-tropical climates.

Furthermore, genetic studies like those of Kim et al. (2001) have explored genetic closeness within the Magnoliaceae family and showing results of shared genetics between different sections. Clarification in how different sections are related provides a basis for investigating hybridization potential. However, no comprehensive research has explored how the *Magnolia* species native to Thailand might be used to enhance resilience and utility in temperate horticulture. Addressing these gaps supports expansion of the genetic and aesthetic diversity of Magnolias in both temperate and exotic regions and in extension offering a larger selection of species available for landscaping (Azuma, Thien & Kawano, 1999). In addition to this, works in the aim of this study could also serve as a base for conservational efforts of Thai magnolias.

Research by Liu et al. (2024) underscored the importance of developing workflows for interspecific hybridization, which could guide future efforts to adapt Thai Magnolias to temperate climates. Such future efforts align with parts of United Nations (n.d.) global biodiversity and climate action goals, such as promoting resilient plant species capable of withstanding extreme weather conditions.

In conclusion, providing insight into these areas not only enhances the understanding of Thai Magnolia species but also supports broader horticultural initiatives that supports hybridization and breeding for aesthetics and resilience in changing climates.

1.1 Aims

The main aim of the study was to evaluate the potential of Thai magnolias for Swedish conditions, focusing on M. champaca, M. x alba, M. sirindhorniae, and M. insignis, based on literature, interviews, and field studies. The aim was furthermore to contextualize the importance on said species, describing some of their uses.

1.2 Material and Methods

1.2.1 Literature Review

A first part of the thesis was conducting a narrative literature review aimed to provide a thorough analysis of Magnolia species native to Thailand. The review put focus on their taxonomic relationship, previous hybridization efforts, possibilities, and challenges. The search for scientific articles was primarily conducted by using the SLU search engine Primo, ScienceDirect and Google Scholar as well as recommended material from teachers and experts, peer reviewed and published in renowned journals.

The literature review focused mainly on more advanced genetic information provided in earlier research. Comparative studies highlighted taxonomic and morphological connections between species with the goal of identifying species with hybridization potential. The literature review also covered and included medicinal properties of one species native to Thailand.

1.2.2 Semi-Structured Interview

Semi-structured interviews were conducted with the intent to gather information about Thai magnolias, especially regarding species seen to be as of importance, including their cultural and traditional use in Thailand. It is interesting to overview cultural importance as this could advocate one species over another. Since existing research does not cover this topic well, the method of semi-structured interviews was deemed suitable to explore the knowledge and experiences of people familiar with these magnolias. According to DiCicco-Bloom & Crabtree (2006), semi-structured interviews allow for a flexible approach to the subject. While a list of pre determined questions guide the conversation the semi-structured interview also allow interviewed experts to talk freely and explore topics that came up during the discussion (Dicicco-Bloom & Crabtree 2006). Two botanists and one magnolia collector were interviewed. Out of integrity the interviewees names are not disclosed.The goal was to use the information gathered, to support this study's recommendation of Thai magnolia species that could be hybridized with temperate magnolias and to furthermore gain knowledge regarding cultural uses considering the research gap of existing studies. The interviews began with giving the interviewees a background to the thesis, topic and research gap. Interviews conducted lasted between 15 and 30 minutes and were recorded for transcription and thereafter deleted.

INTERVIEW GUIDE
Could you describe yourself and what your work consists of?
In what way do you come across magnolia in your work?
What is your personal relationship to the magnolia?
What would you say makes the magnolia special?

Could you describe the cultural use of magnolia in Thailand?
Do you have any favorable species and why?

Table 1. Interview Guide

Interviewee number 1 and 2 both have the role of botanists working at the BKF Forest Herbarium at the Royal Forest Department in Bangkok, Thailand. Both interviews were conducted at BKF.

Interviewee number 3 is a Magnolia grower with two gardens. The interview was conducted in his garden in Chiang Mai, Thailand.

Interviewees will be referred to as *Interviewee 1-3*.

1.2.3 Field observations

Fieldwork involved the direct observation of four different magnolias native to Thailand; *Magnolia champaca, M. x alba, M. insignis* and *M. sirindhorniae.*

Observation of species were done in person with the purpose of viewing and describing the trees in question to further understand their aesthetics and habitus. The selection of these species was based on the results of the literature review to include those with a close genetic relation to sections *Yulania* and *Rhytidospermum*, which is a section that includes Magnolias already hardy to Sweden. It was further based on data analyzed from interviews suggesting species of special interest and ultimately based on availability of specimens. Field observations focused on describing their natural habitats and aesthetic traits relevant to hybridization potential and further to familiarize with the species. The field observation proceeded by photographing the species, noting current habitus and approximate measurements. For some species the available specimens from more than one location were limited and observation could only be done at one location. Such species were *Magnolia insignis* and *M. sirindhorniae.* For *Magnolia champaca* and *M. x alba* there were available specimens at several locations though some not in flowering at the time of visit.
The locations in which the specimens were observed are spread geographically throughout the country with the purpose of viewing the same species under different climatic conditions. The availability of specimens varied between each location.
Locations
Vieng Dok Mai Hom Garden, Doi Saket, Chiang Mai province, Thailand

Khao Hin Sorn Royal Development Center, Phanom Sarakham, Chachoengsao province, Thailand.

Phu Kae Botanical Garden, Chaloem Phra Kiat, Saraburi province, Thailand.
Champi Sirindhorniae, Sap Champa, Lopburi province, Thailand.
Private home Khon Kaen City, Khon Kaen province, Thailand.

1.2.4 Data analysis from interviews

In this study, the interpretation of data from the semi-structured interviews followed a qualitative analysis process, with particular attention paid to the nature of the asked questions. After transcribing the interviews, the data was broken down from multiple readings of the transcript. The choice of using thematic analysis is to pinpoint and examine recurring patterns of themes within the collected data. Using thematic analysis leads to identifying subsequent themes of the collected data from the semi-structured interviews (Clarke & Braun, 2017).

An important feature of implementing thematic analysis is the adaptability to use different themes, which proves useful as the research question can adapt and change during data analysis. The adaptability and depth to the thematic analysis promotes a repeated dialogue between data and theoretical framework. Use of thematic analysis further enables the identification of recurring themes across the interviews while also highlighting differences or nuances in how the participants interpreted and responded to the same questions. Using the structured nature of the interview guide with the open ended questions it leads to different themes emerging from what the interviewees talked about (Clarke & Braun, 2017). Throughout the process of interpreting interviewee answers close attention was paid to instances where participants expanded beyond the scope of the questions, as such answers often provided rich and unanticipated data. When compiling the data, I furthermore carefully considered how the leading nature of some questions might have shaped the overall narrative. After compiling the data, three different themes emerged that will be further discussed in the findings section as *Cultural Importance, Usage* and *challenges*.

1.2.5 Limitations

Although the study will include references from studies conducting genetic and morphological analyses, it will not delve into detailed genetic sequencing or extensive laboratory tests. Instead, the study will focus on a broad taxonomic overview and genetic explanations of their relationships with temperate Magnolias. Additionally, this study will not address the global ecological or climatic impact of Magnolias but will specifically investigate their individual traits and their potential applications in temperate regions. While morphological comparisons will be conducted, no experimental hybridization will be performed within the study.

1.3 Definitions

Magnoliaceae Family and genus ***Magnolia***
The Magnoliaceae family is one of the earliest diverged lineages of flowering plants. Classification of the Magnoliaceae family has been a subject of ongoing research and debate among botanists and is continuously changing as a result of advancements in studies utilizing DNA sequencing. However, traditionally the Magnoliaceae family is divided into the two subfamilies of Magnolioideae and Liriodendroidae. Magnolioideae includes the largest genus, *Magnolia* consisting of more than 300 species (Wang et al. 2020).
Liriodendroidae is a monogeneric subfamily containing genus *Liriodendron* which in turn consists of only two species, *Liriodendron chinense* and *Liriodendron tulipifera* (Wang et al. 2020).

Magnolia Sections and Subgenus
The species within genus *Magnolia* are grouped based on phylogenetic, morphological and geographical evidence in order to understand their evolutionary relationships (Figlar, 2012). **Subgenus** or **Subgenera** is the taxonomic rank below the general genus of *Magnolia* and the subgeneras are like the **sections** (taxononomically subordinate to **subgenus**) divided between species with shared evolutionary traits, such as floral structure, seed morphology, and geographic distribution (Figlar & Nooteboom 2004). According to the (*Figlar, R. B. (2006). A new classification for Magnolia (pp. 69-82). Rhododendrons, Camellias and Magnolias Yearbook.* n.d.)single-genus system the genus *Magnolia* was formerly divided into 1 genus, 3 subgenera and 12 sections including 13 subsections.

Subgenus	**Sections & (**Subsections**)**
Magnolia	***Auriculata, Macrophylla, Rytidospermum*** *(Rytidospermum, Oyama)* ***Gwillimia*** *(Gwillimia, Blumiana)* ***Magnolia, Talauma*** *(Talauma, Dugandiodendron, Cubenses)* ***Kmeria, Manglietia***

Yulania	***Yulania** (Yulania, Tulipastrum)* ***Michelia** (Michelia, Elmerillia, Aromadendron, Maingola)*
Gymnopodium	***Manglietiastrum, Gynopodium***

Table 2. Magnolia classification system of (Figlar 2006).

However, following the most recent classification system proposed by Wang et al. (2020) the genus *Magnolia* is no longer divided into 3 subgenera. The earlier subgenera are now instead classified as distinct sections thought to reflect a more phylogenetically accurate structure based on complete chloroplast genome sequences conducted in the study by Wang et al. (2020). Their proposed classification system consists of one genus – *Magnolia* and 15 sections, some with new names and some that were former subsections. The sections that were grouped together in genuses are still seen as adjacent and phylogenetically related but without the grouping of genera, still reflecting closeness despite large taxonomical changes.

Genus	**Former Sections in use**	**New Sections**
Magnolia	*Talauma, Gwillimia, Macrophylla, Magnolia, Rytidospermum, Oyama, Gynopodium, Kmeria, Manglietia, Yulania, Michelia*	*Splendentes, Tuliparia, Tulipastrum, Maingola*

Table 3. Magnolia classification system of (Wang et al. 2020).

Clades

Clades are the grouping of sections or species within a genus or subgenus. Clades are also known as monophyletic groups, that includes one single ancestor as well as all descendents of the group (University of California Museum of Paleontology n.d.). A clade therefore represents unbroken evolutionary lines which in theory makes it possible to follow a specie of choice through its phylogenetic tree to see where it stems from and what group or species share common ancestors (University of California Museum of Paleontology n.d.).

Temperate Magnolias

Temperate magnolias are those species of *Magnolia* thriving in temperate regions characterized by distinct seasonal variations, including warm summers and cool winters (Britannica u.å.). These magnolias are hardy to a colder climate and inhibit different year cycles compared to those of Thailand.

In the thesis temperate magnolias refers to those *Magnolias* established in trade and used in temperate regions such as Sweden.

Thai Magnolias
The 27 Magnolia species native to the country of Thailand is referred to as a group referred under the term Thai magnolias.

Ethnomedicine or Ethnopharmacology
Ethnomedicine or ethnopharmacology is a field that explores the traditional knowledge and practices related to healthcare and healing across different cultures with a focus on how health, disease and illness is understood within a cultural context (Mahapatra et al. 2019). It is a wide-ranging and interdisciplinary field that examines the utilization of natural remedies and the cultural origins of pharmacologically active compounds (Mahapatra et al. 2019).

NDHF
Phylogenetic studies of plants often rely on analyzing specific DNA sequences to explain evolutionary relationships. A gene proven to be particularly useful for this purpose is the ndhF gene which is found in all vascular plants and is located within the chloroplast genome. As (Kim & Jansen 1995) demonstrates, use of the ndhF gene offers several advantages over other commonly used genes like rbcL due to the ndhF gene being longer and its higher sequence divergence. This among other factors makes ndhF versatile and suitable for resolving phylogenetic relationships (Kim & Jansen 1995). With comparison of ndhF sequences between different plant taxa it is possible to construct phylogenetic trees and gain insight into a plant lineages evolutionary history (Kim & Jansen 1995).

Prezygotic barriers
Prezygotic barriers are mechanisms that prevent interbreeding of different species by blocking fertilization before a zygote is formed ((Uckele et al. 2024). A zygote is the fertilized egg of a plant that forms from fusioning one egg and one sperm cell (De Smet et al. 2010). Prezygotic barriers works by blocking fertilization and thus preventing the forming of a zygote, prezygotic barriers effectively limit hybridization (Uckele et al. 2024)

Beetle pollination syndromes
Pollination syndromes are the co-evolved physical characteristics between plants and pollinators which can be used as a predictor for what type of pollinator a flower will attract (U.S. Forest Service n.d.). According to the United States Forest Service (n.d) typical beetle pollination syndromes would be a large bowl-like flower without physical nectar guides such as flowers of the magnolias.

2. Literature Review

The literature review is divided into three parts. The first part informs about molecular analysis of magnolias and how some sections of magnolias are related. The second part focuses on the reforming of genus Magnolia and further defines relationship within the genus. The third part further focuses on relationship within the genus. Studies in all three parts uses different methods and gene data for analysis but point to similar results.

The literature review emphasizes especially on relations between sections including of native Thai magnolia species and those sections that include species hardy to Sweden.

2.1 Exploring genetic closeness

The possibility for hybridization between certain sections of *Magnolia* (see figure 1 and 2 for *Magnolia* sections) is rooted in their evolutionary relationships, which have been clarified through molecular phylogenetics and phylogenomic analyses. Early work by Kim et al. (2001) reconstructed the phylogeny of Magnoliaceae using ndhF sequences, revealing key relationships among major sections of Magnoliaceae. Their study demonstrates that section *Michelia* which includes many of the native Thai magnolias, forms a clade with sections *Elmerrillia, Alcimandra,* and *Aromadendron.* By forming the clade together with these other sections tells about their close genetic relationship. The study further shows that section Michelia groups phylogenetically with section Yulania (*M. stellata, M. kobus*) by putting them both under former Yulania subgenus. The close association between the species mentioned is supported by shared ndhF sequence similarities, showing that the genome which help ensure successful reproduction remains unchanged (Kim et al., 2001). Furthermore, species of subsection Michelia like *M. champaca, M. citrata* and *M. floribunda* exhibit overlapping floral morphologies like spirally arranged tepals and beetle pollination syndromes as well as climatic adaptions similar to the *Yulania* species. Their close relationship is also demonstrated by proleptic growth and formation of hybrids. Because of these shared traits the prezygotic barriers that normally prevents successful hybridization is reduced. Similar genetic proximity is shown through horticultural hybrids such as *Magnolia* x *loebneri* with parents *M. kobus* and *M. stellata* of subgenus Yulania with the hybrid *Magnolia* x *loebneri* exhibiting intermediate traits and fertility.

Similarly, the study shows that hybridization between sections Rytidospermum and Oyama (*M. tripetala, M. sieboldii*) and section Manglietia (*M. insignis, M. garrettii*) is supported by lingering genetic similarities despite diverging from each other early in evolution. Kim et al. (2001) placed section Rytidospermum at the base of Magnolioideae and thus separating sections Rytidospermum and Manglietia from each other but at the same time the study noted incomplete lineage, which is when genetic variation that derives from an ancestor, possibly mutual, is still present in the species today. Furthermore, the two sections share ancestral traits with each other. For example, both groups have multiple layers of tepals and long gynoecia, which indicates that they share a similar evolutionary process. The fact that Rytidospermum and Michelia both are polyphyletic further suggests latent genes (Kim et al. 2001). Success between the groups can be seen in hybrids like Magnolia 'Melissa Parris' with parents *M. (tripetala x obovata)* 'Silk Road' × *M. insignis* 'Anita Figlar which succesfully merges section Manglietias foliage with the floral robustness of section Rytidospermum (Parris, K. 2017).

Kim et al. (2001) emphasized the need for taxonomic realignment in Magnoliaceae, as molecular data often clashes with the morphology-based classifications. The non-monophyletic nature of traditionally defined sections such as Rytodispermum implies that hybridization potential exists within genetically similar sections. Similarly, this earlier classification model also gives section Michelia a nested position within the Yulania subgenus which supports strategic breeding between temperate and tropical species to combine traits like the cold tolerance of Yulania with the floral wonder of Michelia.

In conclusion, the integration of ndhF phylogenetics through studies by Kim et al. (2001) and nuclear-plastid phylogenomic data provides a robust framework for predicting hybridizational success. By targeting phylogenetically close lineages of *Magnolia* such as Yulania-Michelia whilst using genetic evidence of past hybridization, breeders can systematically develop successful hybrids.

2.2 Wangs new model

More recent phylogenetic studies such as those conducted by Wang et al. (2020) have expanded the earlier framework of Magnoliaceaes genetical relations. The study focuses on analyzing 86 *Magnolia* species and doing so by looking at their complete chloroplast genomes. Analysis of the entire chloroplast genome allows for higher resolution and more complex patterns in contrary to analyzing a single chloroplastic gene like ndhF because it focuses on multiple genes as well as noncoding DNA ((Wang et al. 2020)). Therefore, increasing the possibilities of investigating deeper and more complex evolutionary and phylogenetic relationships and patterns.

The study focuses particularly on solving the deep relationships between species of Magnoliaceae and by doing so they propose a new classification for *Magnolia* as one genus, instead of earlier accepted three subgenera. Their reclassification of Magnoliaceae also address the polypholy of traditional groups such as Rytidospermum. The Rytidospermum section (*M. obovata)* were earlierly considered to be taxonomically ambiguous and separated from other sections but their study shows that section Rytidospermum share genetic similarities with section Michelia through persistent ancestral genetic variation, meaning that they share DNA despite being taxonomically and morphologically separated (Wang et al. 2020). The study groups sections Rytidospermum, Magnolia, Manglietia and Oyama together in the same clade, thus showcasing their shared ancestry (Wang et al. 2020). As mentioned earlier, their shared genetic similarities points towards a mutual ancestor for the sections and in extension, it suggests a possibility for hybridization between them despite their taxonomic and morphological separation.

Wang et al. (2020) further clarified the evolutionary relationships within Magnoliaceae with the revised classification identifying cohesive clades, such as the closely related Michelia and Yulania, now recognized as distinct but adjacent sections. This aligns with Kim et al.'s (2001) findings of overlapping floral traits (e.g., beetle-pollination syndromes) and climatic adaptations suggesting reduced prezygotic barriers between the sections. If the sections share such similarities it is also possible that they share a historical relation or closeness. The genetic data from the study also revealed incongruences with nuclear DNA in clades like Michelia-Yulania, meaning that their genetic shows similarities between the clades. This is possibly due to historical hybridization or gene flow, showing that they stem from a common ancestor or has crossed paths earlier. By sharing preserved genes they can be more likely to hybridize with eachother and therefore something modern breeders can exploit.(Kim et al., 2001).

The research by Wang et al. (2020) emphasizes the importance of taxonomic changes. For example, New World Rytidospermum species (*M. obovata, M. tripelata*) show deeper affinities with Asian Manglietia species (*M. insignis, M. garrettii)* then previously recognized. Research like this can facilitate making experimental crosses between the two sections. Similarly, the clade formed by neotropical magnolia sections Splendentes and Talauma, are shown to be a sister clade to the Asian Gwillimia section (*M. siamensis, M.lilifera, M.championii*) further clarifying relations inbetween sections and adding to the knowledge regarding hybridization of magnolias. According to the study (2020) these two sections are proven hard to distinguish without fruits thus further implying a historical relationship. This in combination with supposed shared evolutions raises the likelihood of successful crosses that can highlight biogeographic and morphological overlaps. The findings of Splendentes, Talauma and Gwillimia is in accordance to earlier research on Magnoliaceae done by Kim & Suh (2013) and Azuma et al. (2001) in which they present similar result and classification.

2.3 *Magnolia* analyzed through both plastid and nuclear genetics

By analyzing multiple genes for information it is possible to dive further into the relations of Magnoliaceae species. The study conducted by Dong et al. (2021) focuses on the evolutionary relationships between specific Magnolia groups and used genome skimming in order to collect genetic information from 48 species of *Magnolia*. Through the information they examined two types of genetic material, one is the plastid genomes which is genetic material found in chloroplast and is inherited from the maternal parent. The other is nuclear DNA which is genetic material from the cell nucleus and contains genes inherited from both parents (Dong et al. 2021).

By comparing both nuclear and plastid genetic information Dong et al. (2021) identified so called cytonuclear conclicts. Such conflicts occur when the genetic information based on the plastid DNA looks different from the genetic information based on nuclear DNA. When the two pictures of the evolutionary relationship does not match it often suggests that hybridization has occurred during that plants evolutionary history and that different species have interbred at an earlier point (Dong et al. 2021)

The study shows section Manglietia as sister of section Oyama when the plastid genetic material is analyzed and as sister of section Rytidospermum when analyzing nuclear genetic material. Furthermore both placements of the Manglietia sections relationship to the two sections were maximally supported by all available genetic material. This shows section Manglietia (*M. garrettii, M.insignis)* can be suitable for hybridization with both temperate magnolia sections mentioned. (Dong et al. 2021) The study also showed hard nuclear incongruenses being widespread in the clade consisting of Oyama, Rytidospermum and Manglietia as well as inside Magnolia, Gwillimia, Michelia and Yulania, further highlighting the fluid evolutionary relationship between the sections. The incongruences can be attributed to past hybridization and introgression among other things (Dong et al. 2021). The analysis from Dong et al. (2021) strongly supports a close relationship between section Yulania and Michelia placing them as sister clades with a consistent relationship in both plastid and nuclear data, despite minor incongruences . Hybridization was shown to be particularly prevalent in section Yulania supported by its consistent high levels of polyploidy compared to other sections, something that is often a result from past hybridization events (Dong et al. 2021).

The genetic data obtained in the study (Dong et al. 2021) furthermore reveals the time of divergence for sections Oyama, Rytidospermum, Maingola, Michelia and Yulania happened in the mid Miocene epoch somewhere between 11.63 and 15.98 million years ago (International Commission on Stratigraphy 2013).
The study furthermore pinpoints the disjunction of Rytidospermums North American and eastern Asian species to have taken place approximately 10.47 million years ago, this also accords to time estimates for divergence from earlier studies such as Nie et al. (2008).
By integrating ndhF phylogenetics (Kim et al., 2001) with whole plastid genome data (Wang et al., 2020) and application of both plastid and nuclear genome data (Dong et al., 2021) a comprehensive roadmap for hybridization is provided. Breeders can strategically target phylogenetically proximate lineages such as Yulania-Michelia or leverage residual genetic overlaps in divergent groups like Rytidospermum and Oyama together with Manglietia, thus enhancing traits like cold tolerance, floral fragrance, or ornamental value. This mixture not only advances horticultural innovation but also explains the evolutionary mechanisms such as incomplete lineage sorting and historical gene flow that shape Magnolia's global diversity and adaptation.

Results from the study by Dong et al. (2021) that particularly focused on detection of hybridization events presents possible relatives to one of the magnolias native to Thailand, *Magnolia champaca* of section Michelia. In this study (2021) *Magnolia champaca* presents a strong nuclear and biparental phylogenetic relationship with *M. campbellii, M. salicifolia* and *M. sinostellata* among others. *M. champaca* shows a strong plastid and maternal phylogenetic relationship to *M. grandiflora, M. acuminata* among others. Yulania being a section of both diploid and polyploid trees suggests it is easily hybridized and not strictly bound to species with two chromosomes. The evidence for the evolutionary connections between the taxa reflects a robust and consistent nuclear and plastid genetic history and can further guide hybridization efforts.

Species name	**Section**	**Phylogenetic support to *M.champaca***
Magnolia acuminata	Tulipastrum	Plastid
Magnolia campbellii	Yulania	Nuclear
Magnolia grandiflora	Magnolia	Plastid
Magnolia salicifolia	Yulania	Nuclear
Magnolia sinostellata	Yulania	Nuclear

Table 4. Phylogenetic relationships of Magnolia champaca inferred from data by Dong. et al (2021).

2.4 Summary of the literature review

NDHF gene sequencing by Kim et al. (2001) has revealed that certain sections of genus Magnolia such as Michelia and Yulania share a close genetic relationship. This in turn increases likelihood of successful hybridization due to shared genomic features and similarities in floral traits. Such genetic closeness would reduce prezygotic barriers hindering cell formation in a potential hybrid. The findings highlight the importance of understanding genetic relationships when selecting species for hybridization.

Wang et al. (2020) used complete chloroplast genomes of 86 *Magnolia* species to revise the Magnoliaceae classification and proposing a single-genus model. Their findings reveal genetic relations between temperate magnolia sections Rytidospermum, Oyama, Yulania and Thai magnolia sections Michelia and Manglietia thus improving predictions for hybridization. The findings by Wang et al. (2020) aligns with earlier studies (Kim et al.2001, Azuma et al. 2001, Kim & Suh 2013.) showing how plastid and nuclear DNA incongruences may result from historical hybridization.

Dong et al. (2021) analyzed 48 species of *Magnolia* using plastid and nuclear DNA, revealing widespread evidence of past hybridization and introgression, introgression being the transfer of genetic material between hybridized species through repeated crossing with a parent specie. The study supports hybrid compatibility for Manglietia with Oyama and Rytidospermum. Strong nuclear-plastid incongruences were found in sections Michelia, Yulania and Gwillimia. The study highlighted Yulanias hybridization potential and polyploidy as well as identifiying *Magnolia champaca*'s genetic relation to species of section Yulania, Tulipastrum and Magnolia thus supporting possible intersectional hybridization.

3. Findings

This section presents an overview of the results from the semi-structured interviews conducted. The findings are discussed in two parts in accordance to the two identified themes from the interviews, supported by quotations and interpretetations from the conducted interviews.

The interviewees had different relations and views on magnolias.Two of the participants had a purely professional relationship to the magnolia, collecting samples for herbarium practices and taxonomic research, however both participants expressed a desire to further indulge in the magnolias such as planting in their own garden. The third participant expressed his relation to the magnolia as a lifelong relationship, he grew up in the garden and cherishes many plants but has a specific interest in Magnolia species.
After conducting the thematic analysis two main themes emerged from the interviews, one regarding importance and values of the trees and one regarding usage of the plant.

3.1 Importance and values

After having shared the topic and discussed the background of the thesis I wanted to know in what ways the magnolias are used by the people of Thailand and for what reasons. The need came naturally after identifying the existing literature gap of usages. The interviews are furthermore be used as recommendation for important species.

Interviewee number 1 shared that the *Magnolias* of Thailand are special to him because each species represents different areas of the country, which emphasizes their versatility and broad adaptability to the countrys different climates. Interviewee number 3 further emphasized on the uniqueness of the species as he mentions they all carry different traits that make one over the other, more popular for use in a certain way. An example of this is his mention of *M. champaca* and *M. x alba* being the predominantly used flowers for offering to temples and for the crafting of *Phuang Lamai* flower garlands due to its sweet scent and its association with purity and elegance. He mentioned that the two are chosen over other readily available species like *M. montana* and *M. lilliifera* for their superior long lasting fragrance. He stated that one single flower of *M.lilliifera* only gives off scent for approximately two hours per day whereas the *M.champaca* and *M. x alba* emits fragrance for several days.

Interviewee number 1 further emphasized on the use of *M.champaca* and *M. x* *alba* as flower garlands and offering flowers as he states that white and yellow are important colors in buddhism. White color is thought to symbolize purity of the soul while the yellow symbolizes humility and detachment from material things. Interviewee number 2 further elaborated on the meaning of the flower traits by emphasizing the scent:

''Champee (M.x alba) and Champaca are used together in flower bowls in the temple because the good scent of the flower is supposed to give you a good soul.'' - (Interview, Interviewee 2, January 22nd, 2025)

Interviewee number 2 also mentioned how *Magnolia sirindhorniae* is of certain importance, being named after princess Sirindhorn with beautiful flowers of the yellow royal color.

3.2 Usages

What furthermore emerged from the interviews were the ways in which the Magnolias are used in Thailand, a topic that is not extensively covered by existing literature.
Interviewee number 3 pointed out that the extensive use of *M. champaca* and *M. x alba* is rooted in its availability:
'*'It (M.champaca/x alba) is used for its good smell but it is not taken to the offering only because of the scent, it is taken because of what trees the people have nearby. Every house has a buddha statue and they take the flower from their garden.''* - (Interview, Interviewee 3, February 11th, 2025)

Below are some of the usages of *Magnolia* in Thailand mentioned by the interviewees.

Phuang Malai
All interviewees mentioned that *M.champaca* and *M.x alba* are used to craft the Phuang Malai flower garland. The flower garlands are given as offering, as a token of respect or kept for good luck. *''A similar use like Phuang Malai is preserving the Champee and Champa flower in a glass jar and give or put in the home.''* - (Interview, Interviewee 3, February 11th, 2025)

Fragrance uses
Interviewee number 1 stated that both *champaca* and *alba* are used for making aromatic oils and car fragrance. He also explained that in the North of Thailand the fragrant *Magnolia* flower is wrapped in banana leaf and sold on the street and roads to waiting motorists.

Wood uses
All three interviewees pointed out the use of magnolia wood for coffin making. Interviewee number 2 clarified that it is a traditional practice for Thai people of higher social standing. Interviewee number 1 revealed that the wood of magnolia is traditionally used in construction and he believed that it was due to the lumber exhibiting a good grain and a high proportion of core wood.
Medicinal uses
The *Magnolia Champaca* tree is highly distributed in Thailand, Myanmar, China, South India and West Bengal and has been used as an ethnomedicine for the treatment of rheumatism and gout among others (Taprial, 2015).
The study by Taprial (2015) shows reported pharmacological activities from the *Magnolia champaca* that suggests its usage as a multi facetted painkiller. It acts anti-diabetic, anti-microbial, and anti-inflammatory among others. The study furthermore shows precognitive uses for the *Magnolia champaca* as an anti-oxidant. The medicinal importance in various illnesses differs between the parts of the plant. For instance the flowers are supposedly used for its fever reducing and diuretic properties while the fruits are used for treating dyspepsia and kidney diseases. Lastly the seeds are used for healing cracked feet and the roots are used for relieving menstruational pain. (Taprial, 2015).

Figure 1. Magnolia champaca Phuang Malai (Suan Sunandha Rajabhat University, 2021).

Figure 2. Conservation of M. champaca & M. champee (Suan Sunandha Rajabhat University, 2021).

3.3 Species consideration

The gathered information from both the literature review and interviews suggest a number of species to be of certain importance and genetic compatibility.

The literature review suggests genetic relations for the two sections Michelia and Manglietia with Rytidospermum, Oyama and Yulania. The literature review also suggest specific species such as *Magnolia champaca* and *M. insignis* as being particularly compatible for hybridization with other magnolias.
The interviews specifically advocates species *Magnolia champaca, M. x alba, M. garrettii* and *M.sirindhorniae* as being particularly important or interesting. The field observations were designed after this specie consideration advocating or favoring a number of potential species.

3.4 Field observation

The field observation focused on viewing several magnolias spanning over different geographical locations. The 4 species observed are described under each headline. One recommended but unavailable species was the *Magnolia garrettii.*

3.4.1 Magnolia champaca

Magnolia champaca of section Michelia was observed in three different locations. The *Magnolia champaca* commonly known as ‘’**Champa’**’ is a large evergreen tree with distinct upright habitus, able to reach heights of 30-50 meters in adult form (Nooteboom & Chalermglin 2009). It is naturally a late successional tree that will grow over other trees. Its slightly conical or cylindrical crown is dense with symmetrical tapering branching and smooth bark of brown to grey color. Lower part of tree usually clear of branching. It has pubescent twigs and stipules, lush foliage with leathery leaves that are ovate or elliptical in shape. Highly fragrant flower yellow to orange yellow with 15 tepals producing a sweet floral smell. The color is associated with humility and detachment from materialism. There is a long geographical distance and a difference in climate between the observed species. It was noted that the *champaca* in the cooler north had a darker green color than the ones observed further south. This can possibly be linked to greater accessibility of water or cooler weather.
The overall appearance of the *Magnolia champaca* is graceful and impressive as it has a rather slender trunk with a large flower filled canopy. It is fragrant when walking past and very showy with its flower display.

Figure 3. Magnolia champaca flower. (Ruengruea, n.d)

Figure 4. Magnolia champaca upright habitus *(2025)*.

Figure 5. Magnolia champaca foliage (2025).

Figure 6. Magnolia champaca flower (2025).

Figure 7. Magnolia champaca dry specimen (2025).

Figure 8. Magnolia champaca dry specimen (2025).

3.4.2 Magnolia x alba

Magnolia x alba was observed in three different locations.

The *Magnolia x alba*, commonly known as **''Champee''** is a medium to large upright evergreen tree able to reach heights of 15-30 meters in adult form (Nooteboom & Chalermglin 2009). It has an umbrella shaped crown and grey smooth bark. Its branches and twigs grows in a spreading way contributing to the appearance of its lush and round crown. The twigs are fragrant when broken and has evenly distributed elliptic to ovate glossy leaves with pubescent undersides. White and strongly fragrant flowers with 10-14 tepals. Its flower color reflect purity of the soul and is a contributing factor to its importance. The Champee is a smaller tree than its supposed parent *Magnolia champaca* and does well for ornamental purposes. At one of the locations there was a tree lined avenue with smaller *Magnolia x alba* that had been pruned in a pollard-like way exhibiting round and bulky canopies. This avenue supports the Champee's use as an ornamental tree.

Figure 9. Magnolia x alba flower (2025).

Figure 10. Magnolia x alba ‘’pollard prune’’ (2025).

Figure 11. Magnolia x alba leaf (2025).

Figure 12. Magnolia x alba ''secondary branch life support'' (2025).

3.4.3 Magnolia sirindhorniae

Magnolia sirindhorniae was observed in two different locations. One location; Champi Sirindhorni is in fact a restoration site for this endangered specie. Farming practices and changes in irrigation has led to the death of the older population of *M. sirindhorniae* in that area. Noteworthy is that the species grows naturally in swamp like areas close to limestone mountains, therefore alkaline soil is important. *Magnolia sirindhorniae* is a medium to large evergreen tree able to reach heights of 25 meters in adult form (Nooteboom & Chalermglin 2009). The *sirindhorniae* has a strong upright habitus, bark mostly grey and trunk clear of branches at lower levels. It has a dense and upright crown. Its glossy leaves are acuminate and spirally arranged with pubescent undersides.. White flowers with 12-15 tepals (Nooteboom & Chalermglin 2009). Its status as endangered combined with its specific habitat of alkaline wet soils suggest it is a late successional specie.

Figure 13. Magnolia sirindhorniae flowers (2025).

Figure 14. Magnolia sirindhorniae foliage (2025).

Figure 15. Magnolia sirindhorniae habitus (2025).

Figure 16. Magnolia sirindhorniae leaves (2025).

3.4.4 Magnolia insignis

Magnolia insignis was observed only at Wieng Dok Mai Hom in Chiang Mai province. *Magnolia insignis* also known as the Red Lotus Tree is a medium to large evergreen tree able to reach heights of 30 meters in adult form (Nooteboom & Chalermglin 2009). It has an upright habitus with a dense, rounded to conical crown and grey smooth bark. Leathery leaves elliptic to oblong with slight pubescent undersides. Large and distinct strongly fragrant flowers ranging in color from white and pale pink to deep red and light purple with 9-12 tepals. The flowers appear near the end of branches which gives the tree a distinct ornamental look. The flower is significantly smaller at the stem which also gives the flower its special voluminous look. The *insignis* most likely grows as part of a secondary forest stand with scattered individuals.

Figure 17. Magnolia insignis flower (2025).

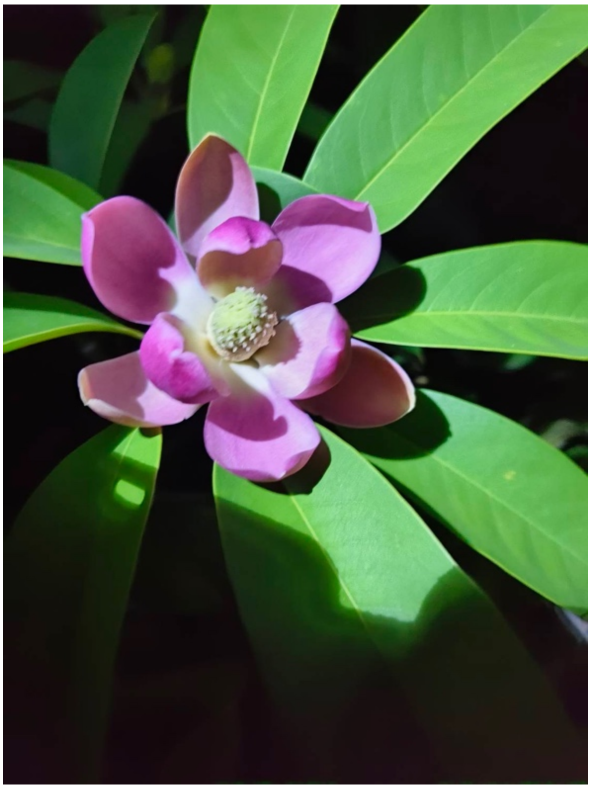

Figure 18. Magnolia insignis flower (2025).

Figure 19. Magnolia insignis flower (Ruengruea n,d).

4. Discussion

The findings of this study suggests that hybridization is possible for the magnolias native to Thailand while highlighting both the promise and complexity of doing so. predominantly of section Manglietia and Michelia. The study suggests that it is possible to hybridize species of sections Manglietia and Michelia with sections Yulania, Rytidospermum, Oyama and Tulipastrum. The study furthermore highlight the characteristics and cultural significance potential of Magnolia species native to Thailand. The Magnoliaceae family, with its ancient evolutionary lineage (Hernández-Vera et al., 2021) provides a rich genetic pool for exploration. Thailand's 27 native Magnolia species (Nooteboom & Chalermglin, 2009) exhibit diverse morphological traits that make them promising candidates for hybridization with temperate magnolias. This aligns with previous studies emphasizing the importance of genetic diversity in horticultural applications (Azuma, Thien & Kawano, 1999).

Hybridization is possible
A central finding is the importance of genetic closeness between Thai and temperate magnolias for successful hybridization. Literature such as Kim et al. (2001) and Wang et al. (2020) underscores that species within sections Yulania and Rytidospermum, already established in Sweden, share evolutionary pathways with several *Magnolia* species native to Thailand. The genetic proximity increases the likelihood of producing viable hybrids, this because reproductive barriers would be lower.

This study identifies *Magnolia champaca* of section Michelia as a particularly promising candidate for hybridization due to its close genetic relationship to section Yulania, supported by nuclear genes and section Tulipastrum, supported by plastid genes (Dong et al., 2021). Similarly, the study shows possibilities for hybridization of Rytidospermum and Oyama (*M. tripetala, M. sieboldii*) with section Manglietia (*M. insignis, M. garrettii*). This insight is supported by J.K. Parris (2018), who demonstrated successful hybridization between *M. insignis* and *M. sieboldii* and also between *M.insignis* and *M.tripelata*. The adaptability of Thai magnolias to temperate climates could expand their use in landscaping and urban horticulture, particularly in regions like Sweden where exotic species are underrepresented (Hunt, 1998). Future hybridization can furthermore enhance Thai magnolias to withstand climatic changes both in its native regions but also in other climates.

The differences between plastid and nuclear genes in genus *Magnolia* as highlighted in mentioned phylogenomic studies, provide additional insights to

hybridization possibilities. The differences or incongruences between the genomic material may arise from historical hybridization events such as introgression. Introgression being the hybridization with a so called genetic parent. This underscores the dynamic evolutionary history of genus *Magnolia.*
For example, nuclear-plastid mismatches in clades such as Michelia-Yulania could reflect past gene flow between the two lineages thus preserving compatibility that can make a hybridization between the two possible. Such genomic plasticity allows breeders to exploit genetic overlaps even between phylogenetically different groups.

What are the possibilities?
There are numerous reasons for introducing species from other parts of the world, either through hybridization or meticulous care. The foremost reason would normally be for ornamental uses, and that value is high for the observed species as they have variying flower size, shape, color and scents as well as beautiful foliages. Introducing hybrids of these special species would greatly increase the number of magnolias possible to grow in temperate climate.

However value also lies beyond pure aesthetics, one such is implementing the species due to cultural significance. One possibility with creating a hybrid between for example *Magnolia champaca* and *M. acuminata* is that people of cultures where this specific tree is important, but has moved or emigrated, can now practice their ways as they would have done for example in Thailand. If a viable hybrid could be created it is not impossible that embassies, temples and other instances would all plant this tree as a representative symbol. Hybridization of suggested species would increase the range of options available in urban planning. An important step for hybridizing specifically *Magnolia sirindhorniae* is to research its soil preferences. Its natural habitat is in swamps with alkaline soil from water provided by limestone mountains. A possibility that arises from a hybrid of this specie lies in whether it could be rid of its very specific soil preference. If a viable hybrid is created that can grow in other soil types it instantly increases its use making it possible for use as ornamental plants in urban context. There lies some ecological risk in introducing hybrids in another climate because it can possibly disrupt the natural pollinating, for instance if a certain insect would change primary pollinator to this tree from a previous one. Furthermore risk lies in the future risk of invasivity. At the point of introduction the species might not show invasive traits but can the future of climatic changes possibly exhibit such traits. Other obstacles to a future hybrid is the uncertainty of producing viable hybrids, an offspring from two different species is not unlikely to be sterile and would possibly be dependent on human fertilization.

Cultural Significance and Medicinal Properties

Semi-structured interviews revealed the cultural importance missing from literature. Interviewers emphasized on the cultural and traditional significance of both *Magnolia champaca* and *Magnolia x alba*. Gathered from the interviews is that species with strong fragrances and distinctive flower forms are highly valued in both ceremonies and gardens. This suggests that hybridization efforts should not only focus on hardiness but also on preserving or enhancing these significant traits. Introducing these ornamental traits into temperate markets shows great potential for increasing the available magnolias.

Ethnomedicinal practices associated with *Magnolia champaca* highlight its value beyond aesthetics and horticulture (Taprial, 2015). Incorporating cultural and medicinal knowledge into hybridization efforts could enhance public interest and support.

Conclusion

This study has highlighted and underscored key *Magnolia* species native to Thailand with potential for hybridization with temperate varieties from a selection grounded in genetics, culture and ecology. By bridging scientific knowledge with cultural practices, the findings offer new ideas to enhancing genetic diversity, aesthetic appeal, and resilience in horticulture, expanding genus Magnolia in both tropical and temperate regions.

Hybridizational efforts does not only contribute to horticultural innovation but also support global conservation goals by creating resilient hybrids capable of adapting to changing climates. The study has furthermore explored the cultural significance of Thai magnolias which further enriches their value, advocating for their inclusion in future research and hybridization efforts. With the continued research of phylogenetical relationships within Magnoliaceae, the possibility of creating viable hybrids will be increased. Although the study does suggest hybridizing endangered *Magnolia* species it is not a replacer for the natural habitats in which the magnolias thrive in originally and can rather be seen as a refinement of an already important species. Furthermore, hybridizing a native Thai magnolia and creating a species that can survive in temperate climate facilitates use of species that are unavailable in their pure form.

References

Azuma, H., Thien, L. B. & Kawano, S. (1999) ‘Molecular phylogeny of Magnolia (Magnoliaceae) inferred from cpDNA sequences and evolutionary divergence of the floral scents’, Journal of Plant Research, 112(4), pp. 291–306.

Azuma, H., García-Franco, J.G., Rico-Gray, V. & Thien, L.B. (2001). Molecular phylogeny of the Magnoliaceae: the biogeography of tropical and temperate disjunctions. American Journal of Botany, 88 (12), 2275–2285. https://doi.org/10.2307/3558389

Britannica (u.å.). Temperate forest | Description, Types, Plants, Animals, & Facts. Temperate Forestn. https://www.britannica.com/science/temperate-forest [2025-03-02]

Clarke, V., & Braun, V. (2017). Thematic analysis. The Journal of Positive Psychology, 12(3), 297–298. https://doi.org/10.1080/17439760.2016.1262613

De Smet, I., S, L., U, M. & G, J. (2010). Embryogenesis - the humble beginnings of plant life. The Plant journal : for cell and molecular biology, 61 (6). https://doi.org/10.1111/j.1365-313X.2010.04143.x

Dicicco-Bloom, B. & Crabtree, B.F. (2006). The qualitative research interview. Medical Education, 40 (4), 314–321. https://doi.org/10.1111/j.1365-2929.2006.02418.x

Dong, S., Wang, Y., Xia, N., Liu, Y., Liu, M., Lian, L., Li, N., Li, L., Lang, X., Gong, Y., Chen, L., Wu, E. & Zhang, S. (2021). Plastid and nuclear phylogenomic incongruences and biogeographic implications of Magnolia s.l. (Magnoliaceae). Journal of Systematics and Evolution, 60 (1), 1–15. https://doi.org/10.1111/jse.12727

Figlar, R. B. (2006). A new classification for Magnolia (pp. 69-82). Rhododendrons, Camellias and Magnolias Yearbook. (u.å.).

Figlar, R.B. (2006). A new classification for Magnolia. Rhododendrons, Camellias and Magnolias Yearbook, 69–82

Figlar, R.B. (2012). A Brief Taxonomic History of Magnolia. A Brief Taxonomic History of Magnolia. https://www.magnoliasociety.org/ClassificationArticle [2025-02-10]

Figlar, R.B. & Nooteboom, H.P. (2004). Notes on Magnoliaceae IV. Blumea - Biodiversity, Evolution and Biogeography of Plants, 49 (1), 87–100. https://doi.org/10.3767/000651904X486214

Hunt, D. (1998). Magnolias and their Allies. papergardensnz. https://papergardens.co.nz/products/magnolias-and-their-allies [2025-02-15]

Kim, K.J. & Jansen, R.K. (1995). ndhF sequence evolution and the major clades in the sunflower family. Proceedings of the National Academy of Sciences, 92 (22), 10379–10383. https://doi.org/10.1073/pnas.92.22.10379

Kim, S., Park, C., Kim, Y. & Suh, Y. (2001). Phylogenetic relationships in family Magnoliaceae inferred from ndhF sequences. American Journal of Botany, 88 (4), 717–728. https://doi.org/10.2307/2657073

Kim, S. & Suh, Y. (2013). Phylogeny of Magnoliaceae based on ten chloroplast DNA regions. Journal of Plant Biology, 56 (5), 290–305. https://doi.org/10.1007/s12374-013-0111-9

Liu, S., Sun, L., Chen, Y., Xu, L. & Yin, Z. (2024) 'The Optimal Workflow for Interspecific Hybridization between Magnolia liliiflora and Michelia figo', SSRN Electronic Journal.

Lorentzon, Kenneth. (1998). Growing magnolias in Sweden In: Magnolias and their Allies, proceedings of an international symposium.

Mahapatra, A.D., Bhowmik, P., Banerjee, A., Das, A., Ojha, D. & Chattopadhyay, D. (2019). Ethnomedicinal Wisdom. I: New Look to Phytomedicine. Elsevier. 35–61. https://doi.org/10.1016/B978-0-12-814619-4.00003-3

Massoni, J., Doyle, J., & Sauquet, H. (2015). Fossil calibration of Magnoliidae, an ancient lineage of angiosperms. Palaeontologia Electronica. https://doi.org/10.26879/435 [2025-01-16].

Nie ZL, Wen J, Azuma H, Qiu YL, Sun H, Meng Y, Sun WB, Zimmer EA. 2008. Phylogenetic and biogeographic complexity of Magnolia- ceae in the Northern Hemisphere inferred from three nuclear data sets. Molecular Phylogenetics and Evolution 48: 1027–1040.

Nooteboom, H. P. & Chalermglin, P. (2009) 'The Magnoliaceae of Thailand', Thai Forest Bulletin (Botany), 37, pp. 111–138.

Parris, K. (2018). Magnolia plant named 'Melissa Parris' (Patent No. US20170354074A1). United States Patent and Trademark Office.

Qiu, Y.-L., Lee, J., Bernasconi-Quadroni, F., Soltis, D. E., Soltis, P. S., Zanis, M., Zimmer, E. A., Chen, Z., Savolainen, V., & Chase, M. W. (1999). Phylogenetic relationships of basal angiosperms: Analyses of five genes from three genomes. International Journal of Plant Sciences, 160(S6), S3–S27.

Suan Sunandha Rajabhat University. (2021). Thai Flower Hanging, the Creative Innovation of Floral Arts [Photograph]. Google Arts & Culture. https://artsandculture.google.com/asset/thai-flower-hanging-the-creative-innovation-of-floral-arts-suan-sunandha-rajabhat-university/KQGFINyNW93i6g?hl=en [2025-04-28]

Suan Sunandha Rajabhat University. (2021). *Preserved Magnolia Champaca, Flower* [Photograph]. Google Arts & Culture. https://artsandculture.google.com/asset/preserved-magnolia-champaca-flower-preserving-suan-sunandha-rajabhat-university/9AFjntPlvAObtw?hl=en [2025-04-28]

Taprial S: A review on phytochemical and pharmacological properties of Michelia champaca Linn. Family: magnoliaceae. Int J Pharmacognosy 2015; 2(9): 430-36. doi: 10.13040/IJPSR.0975-8232.2(9).430-36.

Thailand. (2022). Thailand’s Fourth Biennial Update Report (BUR4). https://unfccc.int/sites/default/files/resource/Thailand_BUR4_final_28122022.pdf [2025-01-11].

U.S. Forest Service (u.å.). Pollinator Syndromes. U.S. Department of Agriculture. https://www.fs.usda.gov/wildflowers/pollinators/What_is_Pollination/syndromes.shtml [2025-03-02]

United Nations, (n.d). Sustainable Development Goals: Goal 15 – Life on Land. https://sdgs.un.org/goals/goal15 [2025-01-28].

University of California Museum of Paleontology (n.d.) Clades within clades. Understanding Evolution. University of California, Berkeley. https://evolution.berkeley.edu/the-tree-room/evolutionary-trees-a-primer/clades-within-clades/ [2025-02-25]

Uckele, K.A., Vargas, O.M. & Kay, K.M. (2024). Prezygotic barriers effectively limit hybridization in a rapid evolutionary radiation. New Phytologist, 244 (6), 2548–2560. https://doi.org/10.1111/nph.20187

Wang, Y., Liu, B., Nie, Z., Chen, H., Chen, F., Figlar, R.B. & Wen, J. (2020). Major clades and a revised classification of Magnolia and Magnoliaceae based on whole plastid genome sequences via genome skimming. Journal of Systematics and Evolution, 58 (5), 673–695. https://doi.org/10.1111/jse.12588

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